EE 320: Electromagnetic Fields & Waves

Term: Fall 2026
Credits: 3.0
Lecture Times & Location: Tuesday & Thursday 4:00–5:15 p.m., Rowan Engineering Center 120
Modality: In-Person

Instructor Information

- **Instructor:** Dr. Elif Kaya (Associate Professor of Electrical & Computer Engineering)
- **Email:** ekaya@university.alkimi.ai
- **Office:** Rowan Engineering Center 216
- **Office Hours:**
  - Monday & Thursday: 1:00–2:30 p.m. (In person, Rowan Engineering Center 216)
  - Friday: 4:00–5:00 p.m. (Virtual via Zoom; link posted in Canvas)
  - Also available by appointment.

Course Description

Static electric and magnetic fields, Maxwell's equations, plane waves, transmission lines, waveguides, and antennas. EE 320 provides a comprehensive introduction to classical electrodynamics and high-frequency wave phenomena essential for RF, microwave, and wireless communications engineering. Beginning with vector calculus formulations of static electric and magnetic fields in dielectric and magnetic media, the course builds to Maxwell's time-varying equations and electromagnetic boundary conditions. Students analyze uniform plane wave propagation, reflection, refraction, transmission line dynamics using the Smith chart, and fundamental concepts of waveguides and antennas.

Prerequisites

PHYS 122 and MATH 240.

Measurable Student Learning Outcomes

Upon successful completion of EE 320, students will be able to:

1. **Evaluate Static Fields and Potentials:** Apply Coulomb's, Gauss's, Biot-Savart, and Ampère's laws in Cartesian, cylindrical, and spherical coordinates to calculate static electric and magnetic fields, potentials, and stored energy.
2. **Formulate Maxwell's Equations:** Express Maxwell's equations in differential and integral forms, incorporating displacement current and Faraday's law, and apply electromagnetic boundary conditions across material interfaces.
3. **Analyze Plane Wave Propagation:** Calculate propagation constant, attenuation, phase velocity, intrinsic impedance, and Poynting power flow for uniform plane waves traversing lossless, lossy, and conducting media.

4. **Solve Transmission Line Problems:** Model distributed transmission lines, calculate characteristic impedance, standing wave ratios (SWR), and input impedance, and design stub matching networks using the Smith chart.
5. **Characterize Waveguides and Antennas:** Determine cutoff frequencies and propagation modes (TE and TM) in rectangular metallic waveguides, and compute radiation resistance, directivity, and gain for fundamental antennas.

Required Course Materials & Approximate Costs

1. **Ulaby, Fawwaz T., and Umberto Ravaioli. *Fundamentals of Applied Electromagnetics*. 8th ed., Pearson, 2020.** Approx. $75 digital rental ($180 purchase; reserve copies available in Alkimi Library).
2. **MATLAB PDE Toolbox and Python Electromagnetics Visualization Modules.** Free educational access provided through university site licensing.
3. **Total estimated cost:** Approx. $0 (library reserve & campus tools) to $75 (textbook rental).

Generative AI Policy (AI Level 2: AI Permitted with Disclosure for Specified Tasks)

In accordance with Alkimi University Academic Policies (Student Handbook §5.8), EE 320 operates under **AI Level 2**.

- **What is permitted:** Students may use AI tools to generate MATLAB or Python code for visualizing 3D electrostatic and magnetic vector fields, plotting radiation patterns, and automating transmission line Smith chart calculations.
- **What is prohibited:** AI models must not be used to perform analytical vector calculus proofs, derive boundary condition equations, solve Poisson's equations, or complete graded problem sets without independent derivation. No AI or network-enabled devices are allowed during examinations.
- **Disclosure:** Any computational code, field plots, or automated impedance matching scripts submitted as part of the computational electromagnetics project must include a declaration identifying the AI assistant consulted, the prompt supplied, and the physical analytical checks performed.

Grading Components and Weights

- **Weekly Problem Sets:** 15% (Due Wednesdays at 11:59 p.m. in Canvas (weeks 2–14; lowest dropped))
- **Biweekly Vector & Field Quizzes:** 10% (Administered in class on alternate Thursdays (weeks 3, 5, 9, 13; lowest dropped))
- **Midterm Exam 1 (Electrostatics & Magnetostatics):** 20% (In class, Thursday, October 1)
- **Midterm Exam 2 (Maxwell's Equations & Plane Waves):** 20% (In class, Thursday, November 5)
- **Computational Electromagnetics & Wave Matching Project:** 10% (Due Friday, November 20 at 11:59 p.m.)
- **Comprehensive Final Examination:** 25% (Thursday, December 17, 2026, 3:30–5:30 p.m.)

Grading Scale (Alkimi University Standard)

- **A:** 93–100% | **A-:** 90–92%
- **B+:** 87–89% | **B:** 83–86% | **B-:** 80–82%
- **C+:** 77–79% | **C:** 73–76% | **C-:** 70–72%
- **D+:** 67–69% | **D:** 60–66% | **F:** Below 60%
- **Extra credit:** No individual extra credit assignments are offered in EE 320.

Course Schedule (Fall 2026)

Week	Dates	Topics & Readings	Assignments & Deadlines
Week 1	Aug 27	**Vector Calculus and Coordinate Systems:** Orthogonal coordinate systems (Cartesian, cylindrical, spherical),	*First day of classes: Wed Aug 26.*

Week	Dates	Topics & Readings	Assignments & Deadlines
		differential lengths, areas, and volumes; gradient, divergence, curl, and Stokes' and divergence theorems. *Reading: Ulaby & Ravaioli Ch. 3.1–3.7*	
Week 2	Sep 1, 3	**Electrostatics: Coulomb's Law and Electric Field:** Coulomb's law, electric field intensity due to continuous line, surface, and volume charge distributions, and electric flux density (D). *Reading: Ulaby & Ravaioli Ch. 4.1–4.3*	*Wed Sep 2: Add/section change deadline.*
Week 3	Sep 8, 10	**Gauss's Law, Electric Potential, and Energy:** Gauss's law in integral and point forms, conservative nature of electrostatic fields, electric scalar potential, and electrostatic energy density. *Reading: Ulaby & Ravaioli Ch. 4.4–4.6*	*Mon Sep 7: Labor Day (no classes). Wed Sep 9: Census date (last day to drop without a W).*
Week 4	Sep 15, 17	**Conductors, Dielectrics, and Boundary Conditions:** Current density, continuity equation, conductor properties, dielectric polarization, permittivity, dielectric boundary conditions, and capacitance formulations. *Reading: Ulaby & Ravaioli Ch. 4.7–4.10*	—
Week 5	Sep 22, 24	**Poisson's and Laplace's Equations:** Derivation of Poisson's and Laplace's equations, uniqueness theorem, one-dimensional boundary-value problems, and method of images. *Reading: Ulaby & Ravaioli Ch. 4.11–4.12*	—
Week 6	Sep 29, Oct 1	**Magnetostatics and Midterm Exam 1:** Biot-Savart law, Ampère's circuital law in integral and differential forms, curl of B, and administration of Midterm Exam 1 during Thursday class. *Reading: Ulaby & Ravaioli Ch. 5.1–5.3*	**Midterm Exam 1 (Electrostatics & Magnetostatics) (in class).**
Week 7	Oct 6, 8	**Magnetic Vector Potential, Inductance, and Forces:** Magnetic flux, vector magnetic potential (A), Lorentz force equation, magnetic torque, self and mutual inductance, and stored magnetic energy. *Reading: Ulaby & Ravaioli Ch. 5.4–5.7*	—
Week 8	Oct 15	**Magnetic Materials and Boundary Conditions:** Magnetization, magnetic susceptibility and permeability, ferromagnetism and hysteresis loops, magnetic boundary conditions, and magnetic circuits. *Reading: Ulaby & Ravaioli Ch. 5.8–5.9*	*Oct 12–Oct 13: Fall break (no classes).*
Week 9	Oct 20, 22	**Time-Varying Fields and Maxwell's Equations:** Faraday's law of induction, motional EMF, displacement current, Maxwell's equations in differential and integral forms, and time-harmonic representations. *Reading: Ulaby & Ravaioli Ch. 6.1–6.6*	—
Week 10	Oct 27, 29	**Plane Wave Propagation in Unbounded Media:** Wave equations for E and H, Helmholtz equations, uniform plane waves in lossless dielectrics, lossy media, skin depth, and good conductors. *Reading: Ulaby & Ravaioli Ch. 7.1–7.4*	—
Week 11	Nov 3, 5	**Wave Polarization, Poynting Vector, and Midterm Exam 2:** Linear, circular, and elliptical polarization, Poynting's theorem and time-average power density, and administration of Midterm Exam 2 in Thursday class. *Reading: Ulaby & Ravaioli Ch. 7.5–7.6*	*Fri Nov 6: Last day to withdraw (W) or elect Pass/No Pass.* **Midterm Exam 2 (Maxwell's Equations & Plane Waves) (in class).**
Week 12	Nov 10, 12	**Reflection and Transmission at Planar Interfaces:** Normal and oblique incidence, Snell's laws, reflection and transmission coefficients, total internal reflection, Brewster angle, and surface waves. *Reading: Ulaby & Ravaioli Ch. 8.1–8.4*	—
Week 13	Nov 17, 19	**Transmission Lines: Distributed Circuit Analysis:** Telegrapher's equations, characteristic impedance, propagation constant, input impedance of terminated lines, voltage standing wave ratio (VSWR); Project due Friday. *Reading: Ulaby & Ravaioli Ch. 2.1–2.6*	**Computational Electromagnetics & Wave Matching Project due Fri Nov 20 at 11:59 p.m.**
Week 14	Nov 24	**The Smith Chart and Impedance Matching:** Smith chart conformal mapping, normalized impedance and admittance,	*Nov 25–Nov 27: Thanksgiving break (no classes).*

Week	Dates	Topics & Readings	Assignments & Deadlines
		quarter-wave transformers, and single-stub shunt matching networks. *Reading: Ulaby & Ravaioli Ch. 2.7–2.11*	
Week 15	Dec 1, 3	**Waveguides and Introduction to Antennas:** Rectangular metallic waveguides, TE and TM cutoff frequencies, group and phase velocity, Hertzian dipole radiation, antenna gain, and effective aperture. *Reading: Ulaby & Ravaioli Ch. 8.6–8.9, 9.1–9.3*	—
Week 16	Dec 8	**Course Synthesis and Final Examination Review:** Comprehensive integration of static and dynamic Maxwell's formulations, wave reflection principles, transmission line matching, and final exam synthesis. *Reading: Review Ulaby & Ravaioli Ch. 3–8*	*Wed Dec 9: Last day of classes. Thu Dec 10: Reading Day.*
Finals	Dec 17	**Comprehensive Final Examination:** Thursday, December 17, 2026, 3:30–5:30 p.m., Rowan Engineering Center 120.	Comprehensive.

Course Policies

Attendance Policy

Class attendance at every lecture is required. Vector calculus applied to electromagnetic field problems is conceptually intricate, and following blackboard derivations in class is essential for developing physical intuition. If an unavoidable illness or university business conflict arises, notify Dr. Kaya in advance. Students who miss the first two class meetings without notifying the instructor may be dropped. Students may miss class for religious observance without penalty if they notify the instructor in writing within the first two weeks of the semester (by Wednesday, September 9, 2026). Absences for university-sponsored activities (athletics, performances, conferences) are excused with a letter from the sponsoring office at least one week in advance.

Late Work Policy

Homework problem sets submitted after the deadline will incur a 15% deduction per 24 hours up to 48 hours late, after which solutions will be published and zero credit awarded. The lowest homework grade and lowest quiz grade will be dropped to accommodate unforeseen illnesses.

Final Exam Policy

The final examination (Thursday, December 17, 2026, 3:30–5:30 p.m.) is scheduled by the University Registrar and can't be moved without the Dean's written approval (Faculty Handbook §5.5). A student with three or more final exams on the same calendar day may reschedule one of them. Requests go to the instructor of the middle exam by the last day of classes. For this term, send the request by Wednesday, December 9, 2026 (Student Handbook §6.4).

Academic Integrity

Alkimi University is an academic community devoted to rigorous scholarship, open intellectual inquiry, and uncompromising ethical conduct. All students are subject to the regulations of the Alkimi University Academic Integrity Policy. Academic dishonesty—including plagiarism, cheating on examinations, unauthorized collaboration, fabrication of empirical data, and unauthorized submission of academic work generated by artificial intelligence—undermines the integrity of the university and carries severe disciplinary sanctions. Sanctions range from a failing grade on an assignment or exam to an administrative course failure recorded as an 'XF' on the official transcript, academic suspension, or expulsion. Suspected violations are formally investigated and resolved through the Office of Academic Integrity in accordance with Faculty Handbook §6. For detailed information, consult the Office of Academic Integrity, Lovell Hall 315, (555) 555-0163, integrity@university.alkimi.ai.

Accessibility Services

Alkimi University is committed to providing equitable educational access and reasonable accommodations for all students with documented disabilities, including physical, sensory, psychological, learning, and chronic health conditions. Students requesting academic accommodations must formally register with the Office of Accessibility Services, Harlan Hall 204, (555) 555-0155, access@university.alkimi.ai. Once approved, students will receive an official Faculty Accommodation Letter detailing approved accommodations. Students should present this letter to the instructor as early in the semester as possible, and at least one week prior to any exam or assignment requiring accommodation. Accommodations cannot be applied retroactively.

Student Wellness and Mental Health

Your physical health, psychological well-being, and mental health are essential to your academic success. If you experience heightened stress, anxiety, depressive symptoms, personal trauma, or academic burnout, free, confidential counseling and medical care are available through the Hollis Health & Counseling Center, located in the Hollis Center. Routine appointments are available Monday–Friday 8:00 a.m.–6:00 p.m. and Saturday 10:00 a.m.–2:00 p.m. during the semester by calling (555) 555-0190 or emailing health@university.alkimi.ai. Urgent, 24/7 crisis psychological counseling is accessible immediately at (555) 555-0199.

Campus Student Support Services

- **Academic Advising Center:** Lovell Hall 101 | (555) 555-0158 | advising@university.alkimi.ai
- **Writing Center:** Whitcombe Library 3rd Floor | Free consultations on papers, reports, and research projects at any stage.
- **Whitcombe Library:** Whitcombe Library, Main Floor | (555) 555-0170 | askalibrarian@university.alkimi.ai
- **Hollis Health & Counseling Center:** Hollis Center | (555) 555-0190 | 24/7 Counseling Line: (555) 555-0199 | health@university.alkimi.ai
- **Electromagnetics Peer Tutoring:** Rowan Engineering Center 140 | Drop-in vector calculus and electromagnetics help available Tuesday and Thursday 5:30–8:00 p.m.