

ECE 540 – Electromagnetic Fields Spring 2026 Syllabus

Instructor

Prof. Jacob Adams
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Class Time

MoWe 1:30 – 2:45 PM, EB3 02220

Office Hours

Prof. Adams: TBD
Other times by appointment.

Course Website

Available on Moodle.

Questions on Course Material

Please use the Moodle message boards to ask questions on the course material. I will respond most quickly to these questions and other students may find the discussion helpful. If you need to send me an email regarding a private matter, such as a grade, please put “ECE 540” in the subject line.

Prerequisites

ECE 303, 422 or equivalent. This course assumes basic familiarity with Maxwell’s equations and electrodynamics, waves, phasors, vector calculus, and transmission lines.

Course Overview

Maxwell's Equations, constitutive relations and boundary conditions; Reflection and refraction of plane waves; Power and energy relations; Wave propagation in anisotropic media; Solutions in rectangular, cylindrical and spherical systems; Electromagnetic theorems; Auxiliary potentials; Green's functions and their applications to radiation and scattering; Numerical solutions of electromagnetic problems using the finite difference time domain method and the method of moments.

Course Texts

Required:

Advanced Engineering Electromagnetics by Balanis (Wiley), 3rd edition, 2024.

Optional References:

Electromagnetic Theory

Theory & Computation of Electromagnetic Fields (Jin)
Time-Harmonic Electromagnetic Fields (Harrington)
Field Theory of Guided Waves (Collin)

Numerical Methods

Numerical Methods for Engineering (Warnick)
The Method of Moments in Electromagnetics (Gibson)
Computational Electrodynamics: The FDTD Method (Taflove)

Course Structure

75-minute lecture/discussion, twice weekly. Homework will be assigned weekly for the first several weeks of class.

Grading (subject to minor adjustments)

Homework:	25 %
Midterm:	25 %
Course Projects:	25 %
Final Exam:	25 %

Grades will be based on the NCSU standard scale:

$97 \leq A+ \leq 100$	$87 \leq B+ < 90$	$77 \leq C+ < 80$	$67 \leq D+ < 70$
$93 \leq A < 97$	$83 \leq B < 87$	$73 \leq C < 77$	$63 \leq D < 67$
$90 \leq A- < 93$	$80 \leq B- < 83$	$70 \leq C- < 73$	$60 \leq D- < 63$

Grades are non-negotiable. However, when assigning “borderline” grades, I will give consideration to students who demonstrate interest and effort in the course (for example, by participating in lecture and the Moodle discussion forum or asking questions in office hours).

Instructional Objectives

Students will be able to:

1. Explain concepts such as permeability, permittivity, conductivity, electric and magnetic field, time harmonic Maxwell’s equations, integral and differential form of Maxwell’s equations.
2. Apply electromagnetic boundary conditions to interfaces between dielectric and conducting materials.
3. Discuss traveling and standing waves, wavelength, polarization, phase velocity, propagation constant, Poynting’s theorem.
4. Formulate mathematical representations of plane waves traveling at arbitrary angles and polarizations using their described properties, and vice-versa.
5. Calculate plane wave reflection coefficient, transmission coefficient, angle of reflection and transmission for normal and oblique incidence.
6. Explain concepts such as image theory, equivalence principle, reciprocity, auxiliary potentials, TEM, TE, and TM modes.
7. Formulate solutions to electromagnetic boundary value problems in rectangular, cylindrical and spherical coordinates.
8. Understand properties and compute values of special functions for cylindrical and spherical systems (Bessel functions, Hankel functions, Legendre polynomials).
9. Derive time stepping formulas for finite difference time domain (FDTD) solution for 1D electromagnetic problems.
10. Analyze the stability and dispersion of an FDTD solution.
11. Develop a point matching solution for the electric field integral equation using the method of moments (MoM).
12. Write and validate Matlab-based codes to solve electromagnetic problems using FDTD and MoM.

Course Schedule

1. Intro and review of Maxwell's equations and constitutive relations
2. Analytical electromagnetics
3. Plane wave propagation, reflection, and transmission
4. Solutions to bounded electromagnetic problems in rectangular coordinates
5. Wave solutions in cylindrical and spherical coordinates
6. Midterm exam
7. Computational electromagnetics
8. Finite difference time domain method
9. The method of moments
10. Finite element method and hybrid methods
11. Final exam

Late Assignments

Homework is due at the beginning of class on the due date. Assignments received after the deadline are considered late. Late homework may be turned in within 2 days following the deadline for half credit. Assignments more than two days late will not be accepted and will result in a zero for the assignment. However, to give you some flexibility on a particularly busy week, your lowest homework grade will be dropped. The projects may not be turned in late and no project grades will be dropped.

Disputed Grades

Students who disagree with a grade on a homework or test may request a regrade. However, *verbal requests for regrades will not be considered*. A written regrade request must be submitted to the instructor within *one week* of the assignment being returned to the class. The student should return the original assignment and attach a separate sheet of paper that identifies the problem being disputed and make a clear argument as to why the grade should be changed. Do NOT mark on the original assignment.

Missed Tests

Under extraordinary circumstances, missed tests may be made up at the instructor's discretion. Contact the instructor as soon as you are aware that you will be unable to take a test on time.

Incomplete Grades, Withdrawals

Information on incomplete grades can be found at [REG 02.50.03 – Grades and Grade Point Average](#). If you encounter a serious disruption to your work not caused by you and you would have otherwise successfully completed the course, contact your instructor as soon as you can to discuss the possibility of earning an incomplete in the course for the semester, including an agreement on when the remaining work must be done in order to change the grade to the appropriate letter grade.

Attendance

Attendance is not required but strongly encouraged.

Use of Generative AI Tools

This course permits you to use generative artificial intelligence (GAI) tools, such as chatbots, text generators, paraphraser, summarizers, or solvers, to get guidance on assignments, as long as you do so in an ethical and responsible manner. You can use these tools to help you learn but not to complete entire assignments. GAI can act like a tutor or TA, not a replacement for your independent thinking.

This means that you must:

- **Not use GAI tools to replace your own thinking or analysis** or to avoid engaging with the course content.
- **Cite or explain any GAI tools you use.** Provide the name of the tool, the date of access, the URL of the interface, and the specific prompt or query you used to generate the output.
- **Be transparent and honest about how you used the GAI tool and how it contributed to your assignment.** Explain what you learned from the GAI tool, how you verified its accuracy and reliability, how you integrated its output with your own work, and how you acknowledged its limitations and biases.

You are accountable for any mistakes or errors made by a GAI tool. Do not rely on the GAI tool to produce flawless or correct results. Transformers are notoriously prone to hallucinations, fabrications, and incorrect math and logic. *These may not be obvious at a glance.* Always check and edit the output before submitting your work.

Using GAI tools in an unethical or irresponsible manner, such as copying or paraphrasing the output without citation or transparency, using the output as your own work without verification or integration, or using the output to misrepresent your knowledge or skills, is considered a form of academic dishonesty and will result in a zero grade for the assignment and possible disciplinary action. If you have any questions about what constitutes ethical and responsible use of GAI tools, please consult with the instructor before submitting your work.

Students with Disabilities

Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with Disability Services for Students at 1900 Student Health Center, Campus Box 7509, 919-515-7653. For more information on NC State's policy on working with students with disabilities, please see the [Academic Accommodations for Students with Disabilities Regulation](#) (REG 02.20.01).

N.C. State University Policies, Regulations, and Rules (PRR)

Students are responsible for reviewing the Policies, Rules, and Regulations which pertain to their course rights and responsibilities. These include: <http://policies.ncsu.edu/policy/pol-04-25-05> (Equal Opportunity and Non-Discrimination Policy Statement), <http://oied.ncsu.edu/oied/policies.php> (Office for Institutional Equity and Diversity), <http://policies.ncsu.edu/policy/pol-11-35-01> (Code of Student Conduct), and <http://policies.ncsu.edu/regulation/reg-02-50-03> (Grades and Grade Point Average).

Academic Integrity and Honesty

Students are required to comply with the university policy on academic integrity found in the [Code of Student Conduct 11.35.01 sections 8 and 9](#). Therefore, students are required to uphold the Pack Pledge: “I have neither given nor received unauthorized aid on this test or assignment.” Violations of academic integrity will be handled in accordance with the [Student Discipline Procedures](#).

Please refer to the [Academic Integrity](#) web page for a detailed explanation of the University’s policies on academic integrity and some of the common understandings related to those policies.

Student Privacy

Originality Checking Software

Turnitin may be used in this course to detect the originality of student submissions.

Class recording statement:

In-class sessions are recorded in such a way that might also record students in this course. These recordings may be used beyond the current semester or in any other setting outside of the course. Contact your instructor if you have concerns.

Other Policies

Students are responsible for reviewing the NC State University PRR’s which pertain to their course rights and responsibilities:

- [Equal Opportunity and Non-Discrimination Policy Statement](#) and [additional references](#)
- [Code of Student Conduct](#)
- [Grades and Grade Point Average](#)
- [Credit-Only Courses](#)
- [Audits](#)

Student Resources

Academic and Student Affairs maintains a website with links for student support on campus, including academic support, community support, health and wellness, financial hardship or insecurity, and more. [Find Help on Campus.](#)

Disability resources

Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with the [Disability Resource Office \(DRO\)](#). For more information on NC State’s policy on working with students with disabilities, please see the [Policies, Rules and Regulations page maintained by the DRO](#) and [REG 02.20.01 Academic Accommodations for Students with Disabilities](#).

Safe at NC State

At NC State, we take the health and safety of students, faculty and staff seriously. The [Office for Institutional Equity and Diversity](#) supports the university community by providing services and resources to support and guide individuals in obtaining the help they need. See the [Safe at NC State webpage](#) for resources.

Supporting Fellow Students in Distress

As members of the NC State Wolfpack community, we each share a personal responsibility to express concern for one another and to ensure that this classroom and the campus as a whole remain a healthy and safe environment for learning. Occasionally, you may come across a fellow classmate whose personal behavior concerns or worries you, either for the classmate's well-being or yours. If you feel this way, I would encourage you to report this behavior to the [NC State CARES website](#).