Physics 2555
Advanced Classical Electricity and Magnetism
Winter/Spring 2026 (2264)

Instructor: Robert Devaty
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Office Hours: Tuesdays and Fridays, 1 – 2 pm, 319 Allen Hall

Grader: Mahdi Sedighi Jafari
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Core Course Tutor: Jackson Wallace
524 Allen Hall (office hours take place in the hallway)
Office Hours: Mondays and Tuesdays, 2 – 3 pm
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Text: *Classical Electrodynamics* (Third Edition) by J.D. Jackson.

The Course: Physics 2555 is the **four**-credit graduate core course in classical electricity and magnetism. The intent is to cover selected material in Jackson, Chapters 1-12 and possibly other topics from the later chapters, if time permits. Topics will include: electrostatics, magneto-statics, time varying fields, electromagnetic waves, waveguides, antennas, and special relativity. Required mathematical background is covered in Physics 2373.

Course Objectives: The student will be able to:

- State Maxwell's Equations, constitutive relations, boundary conditions, and a variety of other important concepts, results and facts about classical electromagnetism (see list of topics at end of syllabus) in both mathematical form and conceptually.
- Apply methods of mathematical physics to solve problems in classical electromagnetism (once again, see list), and be able to interpret the results conceptually.
- Pass the classical electromagnetism component of the comprehensive exam for admission to candidacy for the Ph.D.

Lectures: Mondays and Fridays 10:00 – 10:50 am, Wednesdays 9:00 – 10:50 am, 106 Allen Hall. You are expected to attend all lectures.

Homework: Homework problems will be assigned approximately weekly. Much of the learning in this course takes place by working on problems. It is important to do the homework problems on time and not fall behind. You are allowed to work with others on the homework if you find this helpful, but your solutions should be your own. Cite any assistance, whether from books or people. Do not consult solutions available on the internet. Late homework will not be graded, particularly if it is so late that the solution has been made available and the set has already been graded.

Exams and Grading: There will be two "in-class" exams, scheduled for Wednesday, February 25, and Wednesday, April 8, and a comprehensive final exam on Friday, May 1, during finals week. The final exam will take place in the regular lecture room, Allen 106, and start at 10 am. The "in-term" exams will each count 100 points. The final exam will be worth approximately 150 points. The homework will contribute 150 points. The quizzes at the beginning of

Wednesday lectures contribute 100 points (if they are given regularly). The course total will be about 600 points. Your numerical score will be converted to a letter grade.

Help Session: One or both of my weekly office hours can evolve into a help session if multiple students regularly attend.

Reserve Books: A list of books on classical electrodynamics and related topics appears on the back of this sheet. Some of these books are on reserve in the Engineering Library in Benedum Hall. If you want a book placed on reserve, let me know.

Canvas Site: The Canvas site for this course provides announcements, lecture notes, problem assignments, homework solution sets, etc. It can be found by logging onto https://canvas.pitt.edu/courses/362009

Office Hours: I should generally be available immediately after lecture. Regular weekly office hours are listed at the top of this syllabus. You may also simply stop by my office, but it is best to make an appointment in advance by e-mail or phone. I will also try to schedule a weekly group help session.

Student Opinion of Teaching Surveys: Students in this class will be asked to complete a *Student Opinion of Teaching Survey*. Surveys will be sent via Pitt email and appear in Canvas during the last three weeks of class meeting days. Your responses are anonymous. Please take time to thoughtfully respond, your feedback is important. Read more about *Student Opinion of Teaching Surveys*.

Academic Integrity

Students in this course will be expected to comply with the University of Pittsburgh's Policy on Academic Integrity. Any student suspected of violating this obligation for any reason during the semester will be required to participate in the procedural process, initiated at the instructor level, as outlined in the University Guidelines on Academic Integrity. This may include, but is not limited to, the confiscation of the examination of any individual suspected of violating University Policy. Furthermore, no student may bring any unauthorized materials to an exam, including dictionaries and programmable calculators.

To learn more about Academic Integrity, visit the Academic Integrity Guide for an overview of the topic. For hands- on practice, complete the Academic Integrity Modules.

Disability Resources

If you have a disability for which you are or may be requesting an accommodation, you are encouraged to contact both your instructor and Disability Resources and Services (DRS), 140 William Pitt Union, (412) 648-7890, drsrecep@pitt.edu, (412) 228-5347 for P3 ASL users, as early as possible in the term. DRS will verify your disability and determine reasonable accommodations for this course.

Email Communication

Each student is issued a University e-mail address (username@pitt.edu) upon admittance. This e-mail address may be used by the University for official communication with students. Students are expected to read e-mail sent to this account on a regular basis. Failure to read and react to University communications in a timely manner does not absolve the student from knowing and complying with the content of the communications. The University provides an e-mail

forwarding service that allows students to read their e-mail via other service providers (e.g., Hotmail, AOL, Yahoo). Students that choose to forward their e-mail from their pitt.edu address to another address do so at their own risk. If e-mail is lost as a result of forwarding, it does not absolve the student from responding to official communications sent to their University e-mail address.

Your Well Being Matters

College/Graduate school can be an exciting and challenging time for students. Taking time to maintain your well-being and seek appropriate support can help you achieve your goals and lead a fulfilling life. It can be helpful to remember that we all benefit from assistance and guidance at times, and there are many resources available to support your well-being while you are at Pitt. You are encouraged to visit Thrive@Pitt to learn more about well-being and the many campus resources available to help you thrive.

If you or anyone you know experiences overwhelming academic stress, persistent difficult feelings and/or challenging life events, you are strongly encouraged to seek support. In addition to reaching out to friends and loved ones, consider connecting with a faculty member you trust for assistance connecting to helpful resources.

The University Counseling Center is also here for you. You can call 412-648-7930 at any time to connect with a clinician. If you or someone you know is feeling suicidal, please call the University Counseling Center at any time at 412-648-7930. You can also contact Resolve Crisis Network at 888-796-8226. If the situation is life threatening, call Pitt Police at 412-624-2121 or dial 911.

Physics 2555
Books
Winter/Spring 2026 (2264)
R.P. Devaty

Reserve Books

1. *Classical Electrodynamics* (3rd Edition) by John David Jackson
2. *Modern Electrodynamics* by Andrew Zangwill
3. *Classical Electricity and Magnetism* by Wolfgang K.H. Panofsky and Melba Phillips
4. *Introduction to Electrodynamics* (4th Edition) by David J. Griffiths
5. *The Classical Theory of Fields* by L.D. Landau and E.M. Lifshitz
6. *Electrodynamics of Continuous Media* by L.D. Landau and E.M. Lifshitz

Others

1. *Electrodynamics* by Fulvio Melia
2. *The Classical Electromagnetic Field* by Leonard Eyges
3. *The Feynman Lectures on Physics* (Vol. II) by R.P. Feynman
4. *Principles of Optics* by M. Born and E. Wolf
5. *Electromagnetic Theory* by J.A. Stratton (available on-line through PittCat)
6. *Static and Dynamic Electricity* by W.R. Smythe
7. *Foundations of Electromagnetic Theory* by J.R. Reitz, F.J. Milford and R.W. Christy
8. *Classical Electrodynamics* by Julian Schwinger, L.L. DeRaad, Jr., K.A. Milton and W. Tsai
9. *Optical Properties of Solids*, by Frederick Wooten

Mathematics and Tables

1. *Methods of Theoretical Physics* by P.M. Morse and H. Feshbach
2. *Table of Integrals, Series and Products* by I.S. Gradshteyn and I.M. Ryzhik
3. *Handbook of Mathematical Functions with Formulas, Graphs, and Mathematical Tables* by M. Abramowitz and I.A. Stegun (available on-line through PittCat)

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List of Topics

Electrostatics

1. Review Coulomb's Law, concept of electric field and Gauss' Law
2. Poisson's and Laplace's equations, Green's theorem, uniqueness theorem, solutions with Dirichlet and Neumann boundary conditions
3. Electrostatic potential energy, energy density, capacitance
4. Green's functions in one, two and three dimensions for parallel plates, cylinders and spheres; method of images
5. Solutions of Laplace's equation in two and three dimensions utilizing Fourier series, spherical harmonics and Bessel functions, i.e., solving Laplace's equation in rectangular, spherical and cylindrical coordinates
6. Multipole expansion
7. Macroscopic media, dielectrics. Electrostatics problems with dielectrics. Polarization and energy with dielectrics present. Molecular origin of polarization.

Magnetostatics

1. Review basic equations of magnetism including Biot-Savart and Ampere's Lawa.
2. Vector potential, magnetic induction for a circular loop, localized current distributions, magnetic moment, force and torque, energy of localized current distributions.
3. Macroscopic equations and magnetic materials, boundary conditions on **B** and **H**, methods of solving boundary value problems in magnetostatics.

Time Varying Fields and Plane Waves

1. Faraday's Law, energy in a magnetic field and inductance, Maxwell's displacement current and Maxwell's equations
2. Quasi-static fields and skin depth
3. Vector and scalar potentials, gauge transformations and gauges, wave equation, development of Green's function for wave equation and solution of wave equation
4. Poynting's theorem, conservation of energy and momentum for a system of charged particles and electromagnetic fields, Maxwell's stress tensor
5. Plane waves, linear, circular and elliptical polarization, reflection and refraction of electromagnetic waves at a plane interface between dielectrics
6. Frequency dispersion characteristics of dielectrics, conductors and plasmas. Waves in conducting or dissipative medium.
7. Superposition of waves, group velocity, spreading of a pulse.
8. Causality in the connection between **D** and **E**, Kramers-Kronig relations.

Wave Guides and Resonant Cavities

1. Fields at the surface and within conductors
2. Cylindrical cavities and wave guides
3. Modes in wave guides, energy flow and attenuation in wave guides
4. Resonance and power loss in conducting cavities

Radiation

1. Nonrelativistic treatment of simple radiating systems including electric dipole and magnetic dipole radiation from a localized oscillating source.
2. Center fed linear antenna, half wave and full wave antennas.
3. Scattering at long wavelengths, Rayleigh scattering (blue sky), optical theorem

Relativity

1. Lorentz transformations and basic kinematic results of special relativity, addition of velocities, four vectors, relativistic energy and momentum of a particle
2. Invariance of electric charge, covariance of electrodynamics, transformation of electromagnetic field, covariant notation
3. Lagrangian and Hamiltonian for a relativistic charged particle in an external electromagnetic field, Lagrangian for the electromagnetic field
4. Motion of a charged particle in uniform static electric and/or magnetic field

Radiation from Moving Charges

1. Development of the Lienard-Wiechert potentials and fields using the Green' function solutions of the wave equation. Include discussion of the Heavyside and Feynman fields if this wasn't done earlier.
2. Power radiated by an accelerated charge, the Larmor formula, and the more general relativistic results for linearly accelerated and circularly accelerated charges
3. Frequency spectrum and angular distribution of radiation from accelerated charged particles, synchrotron radiation
4. Thomson scattering

Physics 2555 (CRN 14843)
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2264, Spring 2026
Robert Devaty

Lectures: Mondays and Fridays: 10 am – 10:50 am, Fridays: 9 am – 10:50 am, 106 Allen Hall
Grader: to be determined

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Jan. 11	12 First Class	13	14	15	16	17
18	19 MLK Day	20	21	22	23 Add/Drop Ends	24
25	26	27	28	29	30 UG Ext. Add/Drop Ends	31
Feb. 4	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18 Ash Wednesday, Ramadan 1	19	20	21
22	23	24	25 Exam 1	26	27	28
Mar. 1	2	3 Holi, Purim	4	5	6	7
8 Daylight Savings Time, Spring Recess Begins	9	10	11	12	13 Spring Holiday	14
15 Spring Break Ends	16 Exam Conflict Submission deadline	17	18 Ash Wednesday, Ramadan starts	19	20 Eid Al-Fitr; Monitored Withdrawal	21
22	23	24	25	26	27	28
29	30	31	1 Passover Eve	2	3 Good Friday	4
Apr. 5 Easter	6	7	8 Exam 2	9 Passover ends	10 Orthodox Good Friday	11
12 Orthodox Easter	13	14	15 Tax Day	16	17	18
19	20	21	22	23	24 Last Day	25 Reading Day
26	27 Finals Week	28	29	30 Final Exam	1	2 Last grad class
May 3 Commencement	4	5 Grades Due 11:59 pm	6	7	8	9
10	11	12	13	14 Ascension	15	16