PHYS 532.01W Electromagnetism: Analysis and Applications

COURSE SYLLABUS: Spring 2026

INSTRUCTOR INFORMATION

Instructor: Dr. Robynne Lock
Office Location: STC 238
Office Hours: I will schedule office hours based on a WhenIsGood poll the first week of class
University Email Address: robynne.lock@etamu.edu
Preferred Form of Communication**:** Email
Communication Response Time: 48 hours

COURSE INFORMATION

Materials – Textbooks, Readings, Supplementary Readings

I have referenced a variety of materials in developing this course, and I will provide you access as needed. Some books you might find helpful are listed below, followed by a list of papers we will be reading:

Fleisch, A Student's Guide to Maxwell's Equations (ISBN: 9780521701471). This book is much more readable than a standard textbook. It's a nice overview of E&M. I really like how it builds around Maxwell's Equations as that is how I have structured the course.

Tallarida, *Pocket book of Integrals and Mathematical Formulas*
Any edition will work. This book is a useful reference containing trigonometric identities, integral tables, etc. It was one of my best friends when I was in college.

Bruce J. Hunt, The Maxwellians (1991). This book is a history of the physicists who developed Maxwell's ideas after his death. Maxwell's equations actually don't appear in his work. They are the work of these scientists

A. Zangwill, Modern Electrodynamics (2013). This is a graduate level textbook with many references to additional reading including both historical documents and modern research, another element I think important to include.

A. Garg, Classical Electromagnetism in a Nutshell (2012). This is another graduate level E&M textbook. The author explains in his preface how he wants to put more emphasis on physics than on mathematics

compared to other grad level E&M books. Also noteworthy is that he fully treats E&M in a vacuum before moving into E&M in materials, which is also more similar to my approach.

Griffiths, Introduction to Electrodynamics. This is one of the standard upper division E&M textbooks. It's a useful reference.

E.M. Purcell and D.J. Morin, Electricity and Magnetism (The version I have was printed in 2020, but the original was published in 1963). This is a textbook at the upper division undergraduate level similar to Griffiths.

J.D. Jackson, Classical Electrodynamics (My edition was published in 1999, but the original is from 36 years before that.) This is the standard graduate E&M textbook.

R.W. Boyd, Nonlinear Optics (My edition is from 2003, but the first edition was from 10 years earlier). Nonlinear optics is a field with its beginnings in 1961 and is not part of the standard physics curriculum. It includes the world of frequency doubling and tripling among other things.

Readings

B.J. Hunt, "'Our friend of brilliant ideas,' G.F. Fitzgerald and the Maxwellian Circle," Eur. Rev. 15, 531 (2007).

B. Franklin, "Letter XI," In *Benjamin Franklin's experiments and observations on electricity* (pp. 265-266), Cambridge, MA: Harvard University Press (1941).

T.M. Scaife and A.F. Heckler, "Interference between electric and magnetic concepts in introductory physics," Phys. Rev. ST – Phys. Ed. Res. 7, 010104 (2011).

D. Voss, "Synopsis: A crackling in the air," 2 May 2013. Physics.aps.org. https://physics.aps.org/synopsis-for/10.1103/PhysRevLett.110.185005 13 January 2016.

A.V. Gurevich and A.N. Karashtin, "Runaway breakdown and hydrometeors in lightning initiation," PRL 110, 185005 (2013).

M.W. Ray et al., "Observation of Dirac monopoles in a synthetic magnetic field," Nature 505, 657 (2014).

Y. Cao and B.M. Brizuela, "High school students' representations and understanding of electric fields," PRPER 12, 020102 (2016).

S. Kapon and H. Veksler, "Teaching nonscience majors about electromagnetic radiation," PRPER 16, 020141 (2020).

Course Description

Topics include vector analysis, electrostatics, magnetostatics, Maxwell's Equations, and electrodynamics. Connections to modern applications will be explored. Emphasis will be placed on conceptual understanding. Prerequisites: University physics and calculus up to partial differential equations.

Additional info: This course covers electromagnetism from a variety of perspectives. The course will include traditional advanced electricity and magnetism content, history of electromagnetism, current events in physics, and physics education research relevant to electricity and magnetism.

Note that the traditional advanced E&M content (problem solving) requires calculus, including multivariable calculus. Review resources will be provided at the beginning of the semester. The first two weeks of class will include review of vector calculus

The *syllabus/schedule are subject to change.*

Student Learning Outcomes

1. Students will be able to analyze the divergence and curl of electric and magnetic fields.
2. Students will be able to apply Coulomb's Law and Gauss's Law.
3. Students will be able to apply Ampere's Law.
4. Students will be able to apply Faraday's law and Lenz's law.
5. Students will be able to conceptually explain the meaning of each of Maxwell's equations.
6. Students will be able to describe properties of electromagnetic waves both conceptually and mathematically.
7. Students will be able to discuss the application of findings of physics education research to their own teaching.
8. Students will be able to incorporate history and current events in physics into their own teaching.

COURSE REQUIREMENTS

Minimal Technical Skills Needed

Students need to be able to use myLeo Online, scan assignments and include multiple pages as a single document, video conference, watch YouTube videos, and use Perusall.

Instructional Methods

Each electricity and magnetism content module contains 1-4 videos. Students should plan to watch ~1 video per week. There will be points during each video during which you should pause and work the sample problems before continuing to watch the video. A discussion board can be found in each electricity and magnetism module for you to discuss working problems with fellow students, including both the "in-class" problems for the videos and your homework problems. Each reading assignment will be available for discussion in the Perusall platform. You will have an assignment due approximately every other week alternating between problem sets and reading assignments. See the schedule at the end of the syllabus. There will be 1 midterm and a final covering the electricity and magnetism content. The final is not cumulative. To earn an A in the course, you will also need to complete an annotated bibliography on E&M physics education research AND an annotated bibliography on history and/or modern research/applications of E&M. You and your classmates will participate in peer review for these two assignments before the final versions are due.

Student Responsibilities or Tips for Success in the Course

Students are expected to watch the videos, participate in all discussions, complete all homework assignments, and complete all exams. Students are to be aware of all deadlines and ask questions when directions are unclear.

GRADING

In this course, we will be using specifications-based grading. This is a form of "mastery-based" grading or standards-based grading. In specs-based grading, the focus is not on assigning specific number grades to assignments and calculating averages, but rather completing specific assignments at sufficient quality. I expect anybody who makes a good faith effort throughout the course to be able to obtain a B. To earn an A, you must show a deeper level of understanding by completing additional assignments. The grade scheme is as follows:

Grade of A:

Fulfill all the requirements for a B (see below)
Complete annotated bibliography: PER at sufficient quality
Complete annotated bibliography: history and/or modern research/applications at sufficient quality

Grade of B:

Complete pass 5 out of 6 Perusall assignments at sufficient quality
Complete 5 out of 6 Problem set assignments at sufficient quality
Demonstrate good understanding and skills on the Midterm and Final
Meet requirements for participation in 5 out of 6 Problem set discussions

Grade of C:

Complete 4 out of 6 Perusall assignments at sufficient quality
Complete 4 out of 6 Problem set assignments at sufficient quality
Demonstrate good understanding and skills on the Midterm and Final
Meet requirements for participation in 5 out of 6 Problem set discussions

Grade of D:

Complete 3 out of 6 Perusall assignments at sufficient quality
Complete 3 out of 6 Problem set assignments at sufficient quality
Demonstrate some understanding and skills on the Midterm and Final
Meet requirements for participation in 4 out of 6 Problem set discussions

Grade of F:

Does not meet the minimum requirements for a D

Exceptions: I am human, and I know you are too. If there are extenuating circumstances that you believe have prevented the grading system from properly reflecting your understanding and effort, please contact me, and we can talk about it. I can also be flexible with deadlines if needed.

Details about each type of assignment follow:

Perusall assignments: Perusall is an online system that enables students and instructors to collectively discuss a text as they read. There are 6 reading assignments within Perusall for this course, each a minimum of one journal paper. Reading assignments are due approximately every other week. See schedule at the end of the syllabus and in Perusall itself. On each assignment, I have written a short introduction. Then you read the paper(s) online. You make annotations (notes) as you read to share your thoughts and write questions. You can respond to each other and upvote each other. I will also be participating. I can see how much of the paper you have read and how much time you have spent reading. The system automatically calculates a percentage grade based on number and quality of annotations, interacting with each other, and time spent reading. I have set a threshold for passing. Only passing matters in specs-based grading, not a percentage grade. This should become clear with our first reading assignment, but if you have any questions, please ask.

Problem set assignments: There are 5 problem sets, assigned approximately every other week. See schedule at the end of the syllabus. Sufficient quality for full credit requires a good faith effort on the majority of the problems. You will complete problem sets on your own paper and then either scan them or take their picture and submit them via myLeo Online. Problem Sets should be submitted as a single file. Do NOT upload several jpg files. You are strongly encouraged to discuss your problem set homework with fellow classmates on the class discussion boards. Problem set solutions will be made available after the deadline.

Midterm and Final: There will be 1 midterm and a final. See exam due dates at the end of the syllabus. The exams will be made available one week before the due date. Exams are treated as "take-home" exams. They are open note/open book and untimed. Collaboration is not permitted. The exams primarily test procedural knowledge, though some conceptual understanding is required. Demonstration of understanding is required for credit. Retesting may be possible in extenuating circumstances.

Problem Set discussion: You are expected to participate in the problem discussions to discuss the sample problems from the videos or to discuss the problem set homework. To receive full credit, you must make at least 2 posts, at least one of which must be a reply to another student. Due dates listed in D2L are for the first post. You may make additional posts after the deadline but generally within the time frame of the relevant unit.

Annotated bibliographies: An annotated bibliography is a reference list with comments (annotations) on each reference. Details for these assignments will be included in separate documents, but I will include a brief summary here. Inspired by the reading assignments in Perusall, the additional papers I have included in the Perusall library, and your own interests, you are to locate 5 journal papers on the relevant topic. For each paper, you will write a summary and a reflection on how useful the paper is for teaching practice including any ideas for lessons the paper has given you. Requirements for "sufficient quality" will be included in the other documents with full details. Peer review will be conducted about two-thirds of the way through the semester. Final versions will be due at the end of the semester. There are **two** annotated bibliographies required to earn an A:

- Annotated bibliography: Physics education research on E&M
- Annotated bibliography: History and/or modern research/applications

Course Outline/Calendar

Advanced Electricity and Magnetism Content Schedule

Weeks are labeled by the Monday of each week. Classes begin Monday, 1/13.

1/12 Week 1: Vector calculus review and application
1/19 Week 2: Vector calculus review and application
1/26 Week 3: Electrostatics
2/2 Week 4: Electrostatics
2/9 Week 5: Electrostatics

2/16 Week 6: Electrostatics
2/23 Week 7: Magnetostatics
3/2 Week 8: Magnetostatics
3/9 Spring Break
3/16 Week 9: Electrodynamics
3/23 Week 10: Electrodynamics
3/30 Week 11: Electrodynamics
4/6 Week 12: Electrodynamics
4/13 Week 13: Electromagnetic waves
4/20 Week 14: Electromagnetic waves
4/27 Week 15: Electromagnetic waves
5/4 Final exam week

Problem Set Homework Deadlines:

Homework 1: Vector calculus	1/28
Homework 2: Electrostatics	2/25
Homework 3: Magnetostatics	3/18
Homework 4: Electrodynamics	4/15
Homework 5: Electromagnetic waves	4/29

Physics Education Research Reading Schedule:
Perusall assignments will be on the following journal papers.

Homework 1: History
B.J. Hunt, "'Our friend of brilliant ideas,' G.F. Fitzgerald and the Maxwellian Circle," Eur. Rev. 15, 531 (2007).
B. Franklin, "Letter XI," In *Benjamin Franklin's experiments and observations on electricity* (pp. 265-266), Cambridge, MA: Harvard University Press (1941).

Homework 2: Physics Education Research I
Y. Cao and B.M. Brizuela, "High school students' representations and understanding of electric fields," PRPER 12, 020102 (2016).

Homework 3: Modern research/applications I
D. Voss, "Synopsis: A crackling in the air," 2 May 2013. Physics.aps.org. <https://physics.aps.org/synopsis-for/10.1103/PhysRevLett.110.185005> 13 January 2016.
A.V. Gurevich and A.N. Karashtin, "Runaway breakdown and hydrometeors in lightning initiation," PRL 110, 185005 (2013).

Homework 4: Modern research/applications II
E. Gibney, "Quantum cloud simulates magnetic monopole," Nature (2014). https://doi.org/10.1038/nature.2014.14612
M.W. Ray et al., "Observation of Dirac monopoles in a synthetic magnetic field," Nature 505, 657 (2014).

Homework 5: Physics Education Research II
T.M. Scaife and A.F. Heckler, "Interference between electric and magnetic concepts in introductory physics," Phys. Rev. ST – Phys. Ed. Res. 7, 010104 (2011).

The *syllabus/schedule are subject to change.*

Homework 6: Physics Education Research III
S. Kapon and H. Veksler, "Teaching nonscience majors about electromagnetic radiation," PRPER 16, 020141 (2020).

Perusall due dates:

Homework 1	1/21
Homework 2	2/4
Homework 3	2/18
Homework 4	3/25
Homework 5	4/8
Homework 6	4/22

Exam due dates:

Exams will be made available 1 week before the deadline.

Midterm	3/4
Final	5/6

Annotated bibliography: PER due dates

For peer review	3/18
Final version	5/4

Annotated bibliography: History and/or Modern research/applications due dates

For peer review	4/1
Final version	5/4

TECHNOLOGY REQUIREMENTS

LMS

All course sections offered by East Texas A&M University have a corresponding course shell in the myLeo Online Learning Management System (LMS). Below are technical requirements

LMS Requirements:
https://community.brightspace.com/s/article/Brightspace-Platform-Requirements

LMS Browser Support:
https://documentation.brightspace.com/EN/brightspace/requirements/all/browser_support.htm

Zoom Video Conferencing Tool
https://inside.tamuc.edu/campuslife/CampusServices/CITESupportCenter/Zoom_Account.aspx?source=universalmenu

ACCESS AND NAVIGATION

The *syllabus/schedule are subject to change.*

You will need your campus-wide ID (CWID) and password to log into the course. If you do not know your CWID or have forgotten your password, contact the Center for IT Excellence (CITE) at 903.468.6000 or helpdesk@etamu.edu.

Note: Personal computer and internet connection problems do not excuse the requirement to complete all course work in a timely and satisfactory manner. Each student needs to have a backup method to deal with these inevitable problems. These methods might include the availability of a backup PC at home or work, the temporary use of a computer at a friend's home, the local library, office service companies, Starbucks, a TAMUC campus open computer lab, etc.

COMMUNICATION AND SUPPORT

If you have any questions or are having difficulties with the course material, please contact your Instructor.

Technical Support

If you are having technical difficulty with any part of Brightspace, please contact Brightspace Technical Support at 1-877-325-7778. Other support options can be found here:

https://community.brightspace.com/support/s/contactsupport

STUDENT RESPONSIBILITIES FOR COURSE

CWID and Password

You will need your campus-wide ID (CWID) and password to log into the course. If you do not know your CWID or have forgotten your password, contact the Center for IT Excellence (CITE) at 903.468.6000 or helpdesk@etamu.edu.

Technology-Related Issues

Personal computer and internet connection problems do not excuse the requirement to complete all course work in a timely and satisfactory manner. Each student needs to have a backup method to deal with these inevitable problems. These methods might include the availability of a backup PC at home or work, the temporary use of a computer at a friend's home, the local library, office service companies, Starbucks, a ETAMU campus open computer lab, etc.

TECHNOLOGY REQUIREMENTS AND SUPPORT

Minimal Technical Skills Needed

Students will need reliable computer and internet access for this course. Students must be able to effectively use myLeo email, myLeo Online D2L, and Microsoft Office.

Learning Management System (LMS) – D2L

All course sections offered by East Texas A&M University have a corresponding course shell in the myLeo Online Learning Management System (LMS). Below are the technical requirements:

- View the Learning Management System Requirements Webpage.
- Learn more on the LMS Browser Support Webpage.

Technical Support

If you are having technical difficulty with any part of Brightspace, please contact Brightspace Technical Support at 1-877-325-7778. Other support options can be found on the Brightspace Support Webpage.

Perusall

We will be using Perusall for reading assignments. This is a browser-based platform. Technical support can be found here: https://support.perusall.com/hc/en-us/categories/360002173133-Students

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COMMUNICATION AND SUPPORT

Interaction with Instructor Statement

If you have any questions or are having difficulties with the course material, please contact your instructor. Correspondence will always be through university email (your "myLeo" mail) and announcements in myLeo online (D2L). You will not RECEIVE email through D2L, so be sure to check your ETAMU email for communication. Students are encouraged to check university email daily.

Include the Following in Emails with Instructor:

- Course name and subject in the subject line
- Salutation (Good afternoon, Dr. Jackson)
- Proper email etiquette (no "text" emails – use proper grammar and punctuation)
- Student name and CWID after the body of the email (possibly add to student signature on email)

COURSE AND UNIVERSITY PROCEDURES/POLICIES

Syllabus Change Policy

The syllabus is a guide. Circumstances and events, such as student progress, may make it necessary for the instructor to modify the syllabus during the semester. Any changes made to the syllabus will be announced in advance.

Student Conduct

All students enrolled at the University shall follow the tenets of common decency and acceptable behavior conducive to a positive learning environment. The Code of Student Conduct is described in detail online in the Student Guidebook.

Students should also consult the Rules of Netiquette Webpage for more information regarding how to interact with students in an online forum.

ETAMU Attendance

For more information about the attendance policy, please view the Attendance Webpage and the Class Attendance Policy

Academic Integrity

Students at East Texas A&M University are expected to maintain high standards of integrity and honesty in all their scholastic work. For more details and the definition of academic dishonesty see the following procedures:

Undergraduate Academic Dishonesty University Procedure 13.99.99.R0.03

Undergraduate Student Academic Dishonesty Form

Graduate Student Academic Dishonesty University Procedure 13.99.99.R0.10

Graduate Student Academic Dishonesty Form

Use of Artificial Intelligence

East Texas A&M University acknowledges that there are legitimate uses of Artificial Intelligence, ChatBots, or other software that has the capacity to generate text, or suggest replacements for text beyond individual words, as determined by the instructor of the course.

Any use of such software must be documented. Any undocumented use of such software constitutes an instance of academic dishonesty (plagiarism).

Individual instructors may disallow entirely the use of such software for individual assignments or for the entire course. Students should be aware of such requirements and follow their instructors' guidelines. If no instructions are provided the student should assume that the use of such software is disallowed.

In any case, students are fully responsible for the content of any assignment they submit, regardless of whether they used an AI, in any way. This specifically includes cases in which the AI plagiarized another text or misrepresented sources

Students with Disabilities-- ADA Statement

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you have a disability requiring an accommodation, please contact:

Office of Student Disability Resources and Services

East Texas A&M University

Velma K. Waters Library Rm 162

Phone (903) 886-5150 or (903) 886-5835

Fax (903) 468-8148

Email: studentdisabilityservices@etamu.edu

Website: Office of Student Disability Services

Nondiscrimination Notice

East Texas A&M University will comply in the classroom, and in online courses, with all federal and state laws prohibiting discrimination and related retaliation on the basis of race, color, religion, sex, national origin, disability, age, genetic information, or veteran status. Further, an environment free from discrimination on the basis of sexual orientation, gender identity, or gender expression will be maintained.

Campus Concealed Carry Statement

Texas Senate Bill - 11 (Government Code 411.2031, et al.) authorizes the carrying of a concealed handgun in East Texas A&M University buildings only by persons who have been issued and are in possession of a Texas License to Carry a Handgun. Qualified law enforcement officers or those who are otherwise authorized to carry a concealed handgun in the State of Texas are also permitted to do so. Pursuant to Penal Code (PC) 46.035 and ETAMU Rule 34.06.02.R1, license holders may not carry a concealed handgun in restricted locations.

For a list of locations, please refer to the Carrying Concealed Handguns On Campus document and/or consult your event organizer.

The *syllabus/schedule are subject to change.*

Pursuant to PC 46.035, the open carrying of handguns is prohibited on all East Texas A&M University campuses. Report violations to the University Police Department at 903-886-5868 or 9-1-1.

East Texas A&M Supports Students' Mental Health – Counseling Services

The Counseling Center at East Texas A&M University, located in the Halladay Building, Room 203, offers counseling services, educational programming, and connection to community resources for students. Students have 24/7 access to the Counseling Center's crisis assessment services by calling 903-886-5145. For more information regarding Counseling Center events and confidential services, please visit www.tamuc.edu/counsel

Mental Health and Well-Being

The university aims to provide students with essential knowledge and tools to understand and support mental health. As part of our commitment to your well-being, we offer access to Telus Health, a service available 24/7/365 via chat, phone, or webinar. Scan the QR code to download the app and explore the resources available to you for guidance and support whenever you need it.

As an Institutional Member of the National Association of Schools of Music, East Texas State A&M University supports the Association's commitment to student health and wellness. The following web address provides links to information for resources related to physical and mental well-being, as well as assists in offering preventative measures that students can take to avoid serious and/or chronic conditions: Musician Health and Safety - East Texas A&M University