University of Victoria Department
of Physics and Astronomy

Physics 422 - Electromagnetic Theory

Spring 2025 Syllabus

General Information

Instructor: Arthur Blackburn
Email: ablackbu@uvic.ca
Office: Elliot 108
Office Hours: As arranged within course
Course Webpage: https://bright.uvic.ca/d2l/home/367061
CRN: 22595
Units: 1.5
Hours (Lecture-Lab-Tutorial): 3 - 0 - 0

Lecture Schedule:

Monday and Thursday, 1:00 - 2:20 pm
Clearihue, A221

Office Hours:
Tuesday 3:30 pm – 4:30 pm, Elliott 108

Prerequisites:

PHYS 326; MATH 301; MATH 342; MATH 346, or permission of the department.

Required Materials:

Text: Griffiths, "Introduction to Electrodynamics" (4^{th} or 5^{th} Edition preferred, 3rd is also acceptable). (The approximate cost in 2024 of this book is ~$CAD 80).

In addition, you should have access to a computer with either a Matlab or Python programming environment.

Accommodations:

Accommodations can be made for missed exams/assignments due to illness or other severe affliction, as well as conflicts with classes and religious observances. Accommodations will also be made for issues documented through CAL.

If you miss an exam or assignment, I expect you to contact me as soon as possible. If you anticipate missing a course requirement, you must contact me a reasonable time in advance. If an emergency occurs during a test, please talk to me. I can't help if I don't know about the problem.

Content

This one-semester upper-level undergraduate course in electromagnetic theory, will cover the following topics:

- Electrodynamics
- Conservation Laws
- Electromagnetic Waves
- Potentials and Fields
- Radiation
- Electrodynamics and Relativity

These topics are discussed in chapters 7 to 12 of the textbook "Introduction to Electrodynamics: D. J. Griffiths. The lectures will provide a synopsis of these chapters, emphasize the most important concepts for each of the topics, and supplement this through working upon examples and problems using analytical and numerical approaches. A more detailed description is given later in 'Course Topics and Reading Plan'.

Course Learning Outcomes

Upon successful completion of this course students will have demonstrated:

- Application of Maxwell's equations to predict and calculate the behavior of advanced dynamic and static electromagnetic situations.

- Creation of their own numerical codes either in Matlab or Python for solving, analyzing and presenting static and dynamic electromagnetic field problems.

Assessment and Grading

Assignments: 30%

There will be five assignments throughout the semester, which include a mix of pen-and-paper questions as well as computational questions. These assignments will be due at 12 noon on alternate Mondays, as specified in the date given with each assignment. Late assignments will not be accepted without approval prior to the due date or verified illness.

Assignment Policy: You are allowed to collaborate on assignments, so long as your work and your solutions are your own. I take a very strict stance on copying and academic infringement, but I do understand the value of collaborative work. Discussing with a friend is no different from discussing with a professor, except it will likely help your friend learn the material better! However, if you scribe their answers, I will know and there will be consequences!

Midterm Exam: 20%

The midterm will be a 1-day timed take-home assignment that covers all the material covered up to that point. Students are NOT permitted to collaborate in any way on this work, despite the similarity to an assignment.

Final Exam: 50%

The final exam will be a 2-day take-home exam with traditional problems to solve. It will be comprehensive and require knowledge of all the course material. However, the exam will focus primarily on the material after the midterm, with the pre-midterm material providing the necessary tools and techniques to solve the problems of the final exam.

If the application of this scheme would result in grades that are judged by the instructor to be inconsistent with the University's grading descriptions (as described at https://www.uvic.ca/calendar/undergrad/index.php#/policies under "Undergraduate Academic Regulations – Grading") then the instructor will assign percentages consistent with them.

University Regulations on Academic Integrity

These regulations are summarized https://www.uvic.ca/students/academics/academic-integrity/index.php. For full information, including procedures for dealing with academic integrity infringement, see the webpage linked above.

Academic integrity requires commitment to the values of honesty, trust, fairness, respect, and responsibility. Any action that contravenes this standard, including misrepresentation, falsification or deception, undermines the intention and worth of scholarly work and violates the fundamental academic rights of members of our community.

Several types of academic integrity violations are covered in brief below.

Plagiarism

A student commits plagiarism when he or she:

- submits the work of another person as original work
- gives inadequate attribution to an author or creator whose work is incorporated into the student's work, including failing to indicate clearly the inclusion of another individual's work
- paraphrases material from a source without sufficient acknowledgement as described above

Students who are in doubt as to what constitutes plagiarism in a particular instance should consult their course instructor.

Falsifying Material Subject to Academic Evaluation

Falsifying materials subject to academic evaluation includes, but is not limited to:

- fraudulently manipulating laboratory processes, electronic data or research data in order to achieve desired results
- using work prepared by someone else (e.g., commercially prepared essays) and submitting it as one's own
- citing a source from which material was not obtained
- using a quoted reference from a non-original source while implying reference to the original source
- submitting false records, information or data, in writing or orally

Cheating on Assignments, Tests/Quizzes and Examinations

Cheating includes, but is not limited to:

- copying the answers or other work of another person
- sharing information or answers when doing take-home assignments, tests and examinations except where the instructor has authorized collaborative work
- having in an examination or test any materials or equipment other than those authorized by the examiners impersonating a candidate on an examination or test, or being assigned the results of such impersonation
- *assisting others to engage in conduct that is considered cheating*

Opportunities for in-term feedback to instructor

Students are welcome to provide feedback on the course as it progresses, ideally in discussions during office hours.

Use of Technologies

This course involves a significant amount of calculus, involving perhaps some non-trivial integration and differentiation. Unless explicitly stated in the question, students should answer the questions posed in their work using their prior mathematics knowledge and training, along with that provided in the course, without use of a Computer Algebra System (CAS). However, students are permitted to use a CAS to check their own results. If a CAS is used in the determination or checking of an answer, and that reveals a different answer to that which the student obtained without using a CAS, the student is welcome to note the result obtained by the CAS, stating how or with what system that result was obtained. Provided the student can indicate the key steps that would need to be performed to obtain the result checks obtained by CAS (if it is different to that obtained with CAS), marks will be awarded for the CAS-guided solution, provided the student demonstrates understanding of the mathematical steps required to produce the CAS based solution.

The CAS may be the use of free online tools such Wolfram Alpha https://www.wolframalpha.com/, SymPy within Python, or the symbolic math toolbox in Matlab. Use of other CAS like tools, including those which are integrated with AI based tools such ChatGPT are permitted, provided their use is clearly stated in submitted materials and described as above. If students use such tools they may, at the instructor's discretion, be asked to discuss their use of the tool with the instructor.

Course Topics and Reading Plan

Students are expected to read through the recommended text, to supplement their understanding of the material. Ideally, a cursory quick reading of the chapter related to the topic description should be carried out before the class as below, even though it is unlikely that the student will gain a full understanding of the material in that first reading. The content will of course be reviewed in class, though a significant portion of the class may be spent going over examples. In some cases, which will be pointed out in class, the expectation is that some steps of detailed theoretical proofs may be left for the student to work over in their own time though the instructor will describe the key steps required to make such proofs. A second reading of the relevant section of the text book, as may be required to complete assignments and fully grasp the material, after the class should be performed.

Week	Date (notes)	Assignment # Set	Assignment # Due	Book Chapter	Topics
1	January 6, 2025 January 9, 2025	1		2 -6	**Review and Background**: Gauss's Law, Faraday's Law, Poission's Equation, Multipoles, Polarization, Magentization, Magnetostatics, Magnetization
2	January 13, 2025 January 16, 2025			7	Motional EMF, Maxwell's Equations
3	January 20, 2025 January 23, 2025	2	1	8	**Conservation Laws**: Charge, Energy, Momentum - Stress Tensor
4	January 27, 2025 January 30, 2025			9	**Waves** General Properties, Key Equations Energy and Momentum EM Wave in Matter In Polarizable Matter In Conductive Media Wave Guides
5	February 3, 2025 February 6, 2025	3	2		
6	February 10, 2025 February 13, 2025				
Reading Break	February 17, 2025 (a) February 20, 2025 (b) February 21, 2025 (c)	[Mid Term]	3 [Mid Term]		
7	February 24, 2025 February 27, 2025 (d)			10	**Potentials and Fields** Magnetic Potential Coulomb Gauge and Lorenz Gauge Lorenz Gauge Solutions Jefimenko Equations Lienard-Wiechert Potentials
8	March 3, 2025 March 6, 2025	4			
9	March 10, 2025 March 13, 2025			11	**Radiation** Fields of Point Charges Radiation Generalized Radiation
10	March 17, 2025 March 20, 2025	5	4		
11	March 24, 2025 March 27, 2025 (e)	6*(e)		12	**Electrodynamics and Relativity:** Relativistic Electrodynamics Revision
12	March 31, 2025 April 3, 2025		5		

Notes on the above are on the next page.

a - No Class - Reading Break & Family Day (Holiday)

b - No Class - Reading Break

c - Provisional Date for Mid-Term

d - Honours Fest immediately follows this session. For those of you attending there is time to join this class and honours fest, but if necessary I'll do my best to accommodate those who must leave early.

*e - This 'assignment' will include sample questions. Some I will I go over in last lecture and others where I will post solutions online after classes finish for you to self-evaluate.

Resources

a. UVic Learn Anywhere. UVic Learn Anywhere is the primary learning resource for students that offers many learning workshops and resources to help students with academics and learning strategies.
b. Library resources (https://www.uvic.ca/library/index.php)
c. Indigenous student services (ISS)
d. Centre for Academic Communication (CAC)
e. Math & Stats Assistance Centre (MSAC)
f. Learning Strategies Program (LSP)
g. Academic Concession Regulations
h. Academic Concession and Accommodation
i. Academic Accommodation – Policy AC1205

Further resources and policies

University statements and policies

a. University Calendar - Section "Information for all students"
b. Creating a respectful, inclusive and productive learning environment
c. Accommodation of Religious Observance
d. Student Conduct
e. Non-academic Student Misconduct
f. Accessibility
g. Diversity / EDI
h. Equity statement
i. Sexualized Violence Prevention and Response
j. Discrimination and Harassment Policy

Student groups and resources

a. Student wellness
b. Ombudsperson