

Classical Electrodynamics

Classical Electrodynamics:	Astronomy 9620a / Physics 9302a (Fall 2014)
Lecturer:	Prof. Martin Houde mhoude2@uwo.ca http://www.astro.uwo.ca/~houde
Location:	PAB Room 48
Lectures:	Monday, 10:30 am – 11:20 pm Wednesday, 10:30 am – 11:20 am Friday, 10:30 am – 11:20 am
Recommended text:	Classical Electrodynamics , 3rd edition (John Wiley and Sons), by John D. Jackson.
Useful references:	See the bibliography below.

Contact information:

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I can be reached at my office, especially after class where I will do my best to reserve time to answer your questions. I can also be reached during the week through e-mail for simple inquiries, or to make an appointment. I will try to reply to e-mails within two working days of reception.

Students should regularly check the course's WebCT OWL web site.

Evaluation: The course will contain regular assignments, a mid term exam, and a final exam, worth 30%, 35%, and 35% of your final mark, respectively. *The exams will be closed book, and no electronics equipment (e.g., calculators, computers, etc.) will be allowed unless explicitly authorized ahead of time.* Students absent on an examination day may be allowed to take a make-up exam if they present a note from a medical doctor within a reasonable amount of time. Similar consideration may be given under other exceptional circumstances.

Assignments: You will receive three or four lists of suggested problems during the semester. I will indicate, for each list, which ones should be turned in for your assignments. Some of these problems may be chosen as material for the exams. Students will be allowed to discuss the material amongst them, *and only one copy can be turned in for a small group of students (two or three) if the group worked out the assignment together.* Assignments must be turned in at the requested date. However, a student may miss a due date *once* during the semester, and hand in the late assignment on the following lecture day without incurring any penalty. Otherwise, for *every day* for which they are late, assignments will automatically have a third of the maximum number of points subtracted from their total.

Description

This course is intended to provide the student with the necessary tools to tackle more complex problems than those usually covered in undergraduate courses in electromagnetism. Although the contents of the course will often require some degree of sophistication in the development of the theoretical formalism, numerous examples and problems will be used throughout to help the students grasp the underlying physics.

Course Outline

1. Electrostatics: review, boundary problems, multipoles, macroscopic media.
2. Magnetostatics: review, forces and torques on current distributions, Ampère's Law, magnetic dipoles.
3. Maxwell's equations: macroscopic electromagnetism, conservation laws.
4. Wave propagation, waveguides, and resonant cavities.
5. Magnetohydrodynamics and plasma physics.
6. Radiating systems: spherical (scalar) wave solutions, multipoles expansion of the electromagnetic field.
7. Covariant formulation of electrodynamics: special relativity, four-vectors, Thomas precession, the electromagnetic tensor, and the relativistic origin of magnetic fields.
8. Radiation by moving charges: Liénard-Wiechart potentials, accelerated charges (non-relativistic and relativistic), radiation damping, Abraham-Lorentz evaluation of the self-force, synchrotron and bremsstrahlung radiation.

Bibliography

1. **Classical Electrodynamics**, J. D. Jackson, 3rd edition (John Wiley and Sons). *This is the classic textbook on electrodynamics. Despite having acquired a reputation for being “too difficult” or “too mathematical” in some circles, in my opinion, it is still the best book on the subject. It is beautifully written, although it is true that some of the problems are very difficult to solve. The author is a graduate of Western.*
2. **Classical Electromagnetism**, J. Franklin, 1st edition (Pearson – Addison Wesley). *An excellent and modern approach to classical electromagnetism. The author does not cover quite as much material as Jackson, but the level of the treatment is similar without “skipping” too many steps... The needed mathematics is introduced as the author goes along. An excellent alternative to Jackson.*
3. **Classical Theory of Electromagnetism**, B. Di Bartolo, 2nd edition (World Scientific Publishing Co.). *An excellent book at a level similar to Jackson’s. Its big advantage resides in the fact that the author does not “skip steps” in demonstrations. Previously out-of-print, a new edition came out a few years ago.*
4. **Radiative Processes in Astrophysics**, G. B. Rybicki and A. P. Lightman, (John Wiley and Sons). *An absolutely fantastic book on radiative processes. Although it emphasizes astrophysical processes, physicists can beneficially use it in general. The chapter on special relativity is one of the best I know. The only drawback is the lack of treatment of processes that primarily involve the magnetic field (e.g., magnetohydrodynamics, plasma orbit theory). I will probably refer to it on occasion.*
5. **Introduction to Electrodynamics**, D. J. Griffiths, 3rd edition (Prentice Hall). *A good book, up to the advanced undergraduate level. A fine source for problems.*
6. **Electricity and Magnetism, Berkeley Physics Course, Volume II**, E. M. Purcell, (McGraw-Hill). *A very good introductory book on electromagnetism. It is a good source to go back to, when reviewing the fundamentals.*
7. **The Physics of Fluids and Plasmas. An Introduction for Astrophysicists**, A. R. Choudhuri, (Cambridge). *In my opinion, the best introductory book on the physics of fluids and plasmas. I may refer to it when dealing with magnetohydrodynamics and plasmas.*

University Policies:

Several of the links to material and documents specified in the information below can be found at Western's Student Services web site located at

<https://studentservices.uwo.ca/secure/index.cfm>.

Accessibility: Please contact the course instructor if you require material in an alternate format or if you require any other arrangements to make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 661-2111 x82147 for any specific question regarding an accommodation.

Religious holidays: A student who, due to unavoidable conflicts with religious holidays which (a) require an absence from the University or (b) prohibit or require certain activities (*i.e.*, activities that would make it impossible for the student to satisfy the academic requirements scheduled on the day(s) involved), is unable to write examinations and term tests on a Sabbath or Holy Day in a particular term shall give notice of this fact in writing to his or her Dean as early as possible but not later than November 15th for mid-year examinations and March 1st for final examinations, *i.e.*, approximately two weeks after the posting of the mid-year and final examination schedule respectively. In the case of mid-term tests, such notification is to be given in writing to the instructor within 48 hours of the announcement of the date of the mid-term test. The instructor(s) in the case of mid-term tests and the Dean in the case of mid-year and spring final examinations will arrange for special examination(s) to be written at another time. In the case of mid-year and spring final examinations, the accommodation must occur no later than one month after the end of the examination period involved. It is mandatory that students seeking accommodations under this policy give notification before the deadlines, and that the Faculty accommodate these requests. The list of approved dates is updated annually and is available at Departmental, Dean and Faculty advising offices.

Medical accommodation:

- If you are unable to meet a course requirement due to illness or other serious circumstances, you must provide valid medical or other supporting documentation to the Dean's office as soon as possible and contact your instructor immediately. It is the student's responsibility to make alternative arrangements with their instructor once the accommodation has been approved and the instructor has been informed. In the event of a missed final exam, a "Recommendation of Special Examination" form must be obtained from the Dean's Office immediately. For further information please see:
http://www.uwo.ca/univsec/handbook/appeals/accommodation_medical.pdf
- A student requiring academic accommodation due to illness should use the Student Medical Certificate when visiting an off-campus medical facility or request a Records Release Form (located in the Dean's Office) for visits to Student Health Services. The form can be found here:
<http://www.uwo.ca/univsec/handbook/appeals/medicalform.pdf>

Academic misconduct:

- **Cheating:** University policy states that cheating is a scholastic offence that can result in an academic penalty (which may include expulsion from the program). If you are caught cheating, there will be no second warning. Complete information on the University policies on academic offenses can be found at http://www.uwo.ca/univsec/handbook/appeals/scholastic_discipline_undergrad.pdf
- **Plagiarism:** Students must write their essays and assignments in their own words. Whenever students take an idea or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing (such as footnotes or citations). Plagiarism is a major academic offence. For more details, see http://www.uwo.ca/univsec/handbook/appeals/scholastic_discipline_undergrad.pdf
- Plagiarism or cheating will not be tolerated. Penalties will vary depending on the seriousness of the offence. They can range from a grade of zero on an assignment or essay, to failure of a course, to expulsion from the University.
- If you have any questions at all on this issue please consult with your instructor.

Health and Wellness

As part of a successful graduate student experience at Western, we encourage students to make their health and wellness a priority. Western provides several on campus health-related services to help you achieve optimum health and engage in healthy living while pursuing your graduate degree. For example, to support physical activity, all students, as part of their registration, receive membership in Western's Campus Recreation Centre. Numerous cultural events are offered throughout the year. Please check out the Faculty of Music web page <http://www.music.uwo.ca/>, and our own McIntosh Gallery <http://www.mcintoshgallery.ca/>. Information regarding health- and wellness-related services available to students may be found at <http://www.health.uwo.ca/>

Students seeking help regarding mental health concerns are advised to speak to someone they feel comfortable confiding in, such as their faculty supervisor, their program director (graduate chair), or other relevant administrators in their unit. Campus mental health resources may be found at http://www.health.uwo.ca/mental_health/resources.html

To help you learn more about mental health, Western has developed an interactive mental health learning module, found at http://www.health.uwo.ca/mental_health/module.html. This module is 30 minutes in length and provides participants with a basic understanding of mental health issues and of available campus and community resources. Topics include stress, anxiety, depression, suicide and eating disorders. After successful completion of the module, participants receive a certificate confirming their participation.