Course Outline: Phys 1004 A/B/C, Winter 2024
Introductory Electromagnetism and Wave Motion

Course description and prerequisites

This calculus-based course provides an introduction to electricity and magnetism with emphasis on mastering the physics concepts required by students in the engineering programs. It covers: electric and magnetic fields and associated forces, potential and potential energy; magnets; electromagnetic induction; alternative current; electric circuits; and, electromagnetic waves. References to many applications and real-world examples are used frequently. The associated laboratory and tutorial sessions alternate each week, and provide an essential complement to the lectures. Student evaluations are based on labs, tutorials and quizzes, in addition to a final exam which is formally scheduled. Students are required to obtain a satisfactory grade in the laboratory component, as well as overall to pass this course.

This course is intended for students who have already taken MATH 1004, ECOR 1101 or ECOR 1053, or ECOR 1045 and ECOR 1046 (which may be taken concurrently), or PHYS 1001 or PHYS 1003 or PHYS 1007 (with the additional requirement of having obtained at least B- in PHYS 1007), or *with explicit permission from the Physics Department*

Note: *Lectures are three hours per week and laboratory or tutorial sessions are an additional three hours per week. Students are also* ***expected*** *to* ***read selected chapters*** *in the* ***textbook*** *and exercise, including by* ***solving*** *the* ***suggested problems*** *in the textbook and the required* ***weekly quizzes****.*

Instructors and contact information

Alain Bellerive	PHYS 1004 section A instructor	alainbellerive@cunet.carleton.ca
Andrew Robinson	PHYS 1004 section B instructor	andrewrobinson@cunet.carleton.ca
Dag Gillberg	PHYS 1004 section C instructor	daggillberg@cunet.carleton.ca
Jesse Lock	Lab & tutorial groups coordinator	jlock@physics.carleton.ca

Material for the lectures, labs and tutorials is available on the course Brightspace page. It is very important that ***each student identifies his or her lab & tutorial group***. Student hours are posted on Brightspace. The Brightspace websites should be consulted carefully and frequently.

Email communications must be done using your Carleton University account. Email early about any possible issues. Please keep copies of all exchanges until the end of the term.

Textbook

Fundamentals of Physics, *12th Edition*, ***Halliday, Resnick & Walker***, John Wiley & Sons Canada Ltd. The textbook can be bought (or rented) at the Carleton bookstore.

Course philosophy and objectives

Physics provides an ideal opportunity to learn the art of quantitative thinking, i.e. learning how to successfully turn an abstract concept into a concrete calculation or measurement. In order to solve a problem, you must critically examine the information available in a given situation; determine an effective method to obtain the solution and carry through with confidence, including a critical examination of the final answer. These skills will serve you throughout your future career. This course is a good step towards that end. The goal of physics is to understand the physical universe and be able to accurately describe and predict what is observed. Physics is based on such critical thinking, and hence helps to develop independence and free thinking. An understanding of physics helps you perceive the world around you in a more comprehensible, enjoyable, and fascinating way. That being said, learning physics is not a spectator sport. To learn physics, you must do work outside of class thinking about, and interacting with, the course material. ***No one ever learns physics by simply reading about it or listening to someone talk about it. You learn by making the effort to understand the course material and by solving problems using the principles learned.*** *The standard at university is that you spend one hour outside of class for every hour in class.*

Course delivery

This course is delivered in person as a mixture of lectures, tutorials, labs and student hours, as well as asynchronous activities (quizzes, recordings and slides). The specific dates and activities are described below. The asynchronous activities are intended to provide flexibility to students. Students are expected to remain up to date with the deadlines and due dates as provided by the instructors. In practice, this course requires Internet access and a computer.

Lectures are in-person and synchronous, but the lectures will also be recorded and made available on Brightspace. This enables access for students that occasionally might have conflicting commitments or in case of any unforeseen emergency. If remote students wish not to be recorded, they need to leave their camera and microphone turned off. Students will be notified at the start of the session when the recording starts. ***Please note this is not a remote virtual course and in-person attendance for labs and tutorials is mandatory.***

Also, please note that course materials and recordings are protected by copyright. These are for your own educational use, but you are not permitted to publish to third party sites, e.g. social media sites or any course material websites. ***All solutions and answers to any quiz or exam in this course must be your own work.***

Lectures

This course is divided into 25 lectures. Each lecture is an in-person 80-minute traditional lecture. Each instructor posts on Brightspace the lecture material and announces in in-class guidelines specific to a given lecture section. In addition, each instructor has their own student hour according to the schedule of the respective section, as detailed on Brightspace. Below is the list of the topics that will be covered within each week, as well as the corresponding textbook sections recommended for reading. The table below also details the concepts of the lectures and clearly identifies the subject matters of each bi-weekly tutorial test.

Week	Subject	Textbook chapter	Quiz due
1	Electrostatics (*week of Jan 8*) Electric field due to discrete charges	**Chap 3:** Vectors (review) **Chap 21:** Coulomb's Law **Chap 22:** Electric fields (part I)	Jan 15
2	Electric field due to continuous charge distributions (*week of Jan 15*)	**Chap 22:** Electric fields (part II)	Jan 22
3	Gauss' law (*week of Jan 22*)	**Chap 23:** Gauss' Law	Jan 29
4	Work and energy (*week of Jan 29*)	**Chap 7:** Kinetic energy and work **Chap 8:** Potential energy and conservation of energy **Chap 24:** Electric potential energy	Feb 5
5	Potential energy (*week of Feb 5*)	**Chap 24:** Electric potential energy	Feb 12
6	Capacitance (*week of Feb 12*)	**Chap 25:** Capacitance	Feb 26
Reading week			
7	Magnetic fields (*week of Feb 26*)	**Chap 28:** Magnetic fields	Mar 4
8	Magnetic fields (*week of Mar 4*)	**Chap 29:** Magnetic fields due to currents	Mar 11
9	Induction (*week of Mar 11*)	**Chap 30:** Induction and Inductance	Mar 18
10	AC circuits (*week of Mar 18*)	**Chap 31:** EM oscillations and alternating current	Mar 25
11	Maxwell's equations (*week of Mar 25*)	**Chap 32:** Maxwell's equations	Apr 1
12	Electromagnetic waves (*week of Apr 1*)	**Chap 33:** Electromagnetic waves	Apr 8
13	Review (*week Apr 8*)		

Detailed lecture plan

Lecture & Test	Topic	Lecture date
0	Prelecture reading: Chap 3: Review vectors	
1 Test 1	Chap 21: Coulomb's Law Electric Charge Conductors and Insulators Coulomb's Law Charge Is Quantized and Charge Is Conserved	Jan 8
2 Test 1	Chap 22: Electric Fields The Electric Field and Electric Field Lines The Electric Field Due to a Point Charge	Jan 10
3 Test 2	Chap 22: cont'd Electric Field Due to an Electric Dipole Electric Field Due to a Line of Charge	Jan 15
4 Test 2	Chap 22: cont'd Electric Field Due to a Ring or Charged Disk A Point Charge in an Electric Field A Dipole in an Electric Field	Jan 17
5 Test 2	Chap 23: Gauss' Law and Electric Flux Flux of an Electric Field Gauss' Law and Coulomb's Law	Jan 22
6 Test 2	Chap 23: cont'd A Charged Isolated Conductor Gauss' Law: Cylindrical Symmetry Gauss' Law: Planar Symmetry Gauss' Law: Cylindrical, Planar and Spherical Symmetries	Jan 24
7 Test 3	Chap 7: Kinetic Energy and Work Chap 8: Potential Energy and Conservation of Energy Work Done on a System by an External Force	Jan 29
8 Test 3	Chap 24: cont'd Potential Due to a Group of Point Charges Potential Due to an Electric Dipole	Jan 31
9 Test 3	Chap 24: cont'd Potential Due to a Continuous Charge Distribution Calculating the Field from the Potential Electric Potential	Feb 5
10 Test 3	Chap 24: cont'd Energy of a System of Point Charges Potential of a Charged Isolated Conductor	Feb 7
11 Test 4	Chap 25: Capacitance Calculating the Capacitance Capacitors in Parallel and in Series Energy Stored in an Electric Field	Feb 12
12 Test 4	Chap 25: cont'd Capacitor with a Dielectric; Atomic View of Dielectrics Dielectrics and Gauss' Law Chap 26: Definition of current as a differential	Feb 14

13 Test 4	Chap 28: Magnetic Fields What Produces a Magnetic Field? Definition of the B-field Crossed Fields: Discovery of the Electron	Feb 26
14 Test 4	Chap 28 cont'd The Hall Effect A Circulating Charged Particle Magnetic Force on a Wire, Torque on a Current Loop The Magnetic Dipole Moment (*)	Feb 28
15 Test 5	Chap 29: Magnetic Fields due to Currents Force Between Two Parallel Currents Ampere's Law , Solenoids and Toroids A Coil as a Magnetic Dipole	Mar 4
16 Test 5	Chap 29 cont'd Ampere's Law , Solenoids and Toroids A Coil as a Magnetic Dipole	Mar 6
17 Test 5	Chap 30: Induction and Inductance What Is Physics? Two Experiments Faraday's Law of Induction and Lenz's Law Induction and Energy Transfers, Induced Electric Fields	Mar 11
18 Test 5	Chap 30, cont'd Inductors and Inductance, Self-Induction (*) RL Circuits and Energy Stored in a Magnetic Field Energy Density of a Magnetic Field Mutual Induction (*)	Mar 13
19	Chap 31: Electromagnetic Oscillations & Alternating Current LC Oscillations, Qualitatively The Electrical–Mechanical Analogy LC Oscillations, Quantitatively	Mar 18
20	Chap 31, cont'd Damped Oscillations in RLC Circuit Alternating Current Forced Oscillations Three Simple Circuits and The Series RLC Circuit Power in Alternating-Current Circuits Transformers	Mar 20
21	Chap 32: Maxwell's Equations Gauss' Law for Magnetic Fields Induced Magnetic Fields	Mar 25
22	Chap 32, cont'd Displacement Current, Maxwell's Equations	Mar 27
23	Chap 33: Electromagnetic Waves The Traveling EM Wave, Quantitatively Energy Transport and the Poynting Vector Polarization	April 1
24	Review+catch-up	April 3
25	Course review	April 8

Weekly quizzes

Each week, there is a quiz administered through Brightspace. These are due at the beginning of the week (Mondays at midnight). You have at most three attempts to complete each quiz, and plenty of time to complete each attempt (two hours).

The best 10 of 12 quizzes will count towards your final mark.

If there is any discrepancy between the marks posted on Brightspace and your calculated values, notify the instructor immediately.

Numerical answers

When answering the assignment questions requires a calculation, enter the answer when appropriate in scientific notation with three **significant figures**, e.g. 1.60×10^{-19}. You are allowed a 5% deviation between your answer and the exact one calculated within Brightspace to account for rounding errors. If the question explicitly asks for a different number of significant figures or demands an answer with a certain number of digits of precision, then please follow those specific instructions. If the significance or the accuracy of the answer deviates from the stated ranges, the question or problem will be marked as incorrect.

Ensure to always take careful note of the units of your answer. Typically it is expected that the answer will follow SI units (e.g. m, s, J), however there are occasions in which non-standard units will be required. Such instances will be noted in the question itself, e.g. “Express your answer in km”. Units are not to be entered with the numerical answer for these assignments.

Labs and tutorials

All labs and tutorials will be held in person. No online alternatives will be offered.

Labs and tutorials start the week of **January 8, 2024** with an introduction and calculus review. ***It is imperative that all students attend the first lab session!*** You can attend only the section that you are registered in. ***All the changes (e.g. exemptions) must be arranged with the Lab Coordinator, Mr. Jesse Lock at the start of term.*** Lab exemptions will only be considered for students that have previously taken the course and completed all of the labs. You are not automatically given a lab exemption - you must apply for it no later than **January 26th**. To apply for a lab exemption, please contact the Lab Coordinator, **Mr. Jesse Lock (jesselock@cunet.carleton.ca)**. Lab exemptions will be considered on a case-by-case basis at the discretion of the Lab Coordinator.

The grade for each lab will be based on an in-class lab write-up. All lab work (write-ups) counts towards your total lab grade for the course. ***No grade will be dropped.*** All lab write-ups must be completed and submitted by the end of each lab session. ***No lab work will be accepted for grading outside of the lab.***

If you miss a lab, contact Mr. Jesse Lock (or your lab supervisor) immediately.

Lab #	Title	Deadline for report	Weight (%)	Week of
1	***Electrostatics***	End of the lab	20	January 15, 2024
2	***DC Circuit***	End of the lab	20	January 29, 2024
3	***Magnetic Balance***	End of the lab	20	February 12, 2024
4	***Oscilloscope***	End of the lab	20	March 4, 2024
5	***RC & RLC Circuits***	End of the lab	20	March 18, 2024

There will be a tutorial on each alternating week with the labs. The structure of the tutorial is as follows.

A set of tutorial problems will be posted on the lab/tutorial Brightspace website at least a week before the tutorial session. Students should attempt to solve all these problems in order to prepare for the tutorial test. At the start of the tutorial session the instructor will go through a new problem that you have not seen before on the board. Then, the TAs will demonstrate solving the practice problems and answering questions about the tutorial problem set. The last hour of the tutorial will be a close-book test consisting of two multiple choice problems and one long-answer problem (*i.e.* the tutorial test has a 45 minutes duration).

The grade for the tutorial test and the multiple-choice quiz will be combined to provide the final Tutorial Test grade for each of the 5 tutorial sessions this semester.

The four highest test grades will be used to determine the final Tutorial Test score.

Students must attend the tutorial only in the lab section to which they belong. Exceptionally, to be able to attend a different section, students must obtain permission from the lab coordinator **Mr. Jesse Lock (jesselock@cunet.carleton.ca)**. Such permission will usually be granted only for emergencies or medical reasons. If you cannot attend your own lab section one week due to e.g. medical reasons, let us know **AS SOON AS POSSIBLE** so that you can be rescheduled to a different section.

Final exam

There is no mid-term examination in this course. We regard the five tutorial tests, the suggested problems in the textbook and the weekly quizzes, as the main avenues for providing performance feedback and guidance to the students in this course. ***If you do not perform to your own satisfaction, it is imperative to discuss this with your instructors during student hours or by email. Do not leave this consultation until the end of the course.*** Effective assistance is best obtained sooner than later.

The final examination will be formally scheduled during the regular April final exam period and announced toward the end of the term. ***It is the responsibility of the students to be present during the final exam period; in particular, holiday travel arrangements must not be made before the final exam date is known. The final exam may include questions related to the material contained within the lab portion of the course. Please note that attending the final exam is mandatory.***

Grade distribution

Weekly quizzes (best 10 out of 12)	15%
Tutorials (best 4 out of 5)	25%
Labs (all 5 count)	35%
Final examination	25%
TOTAL	**100%**

Attending all labs and tutorials is mandatory. Also, students must obtain at least 50% of the lab component, as well as at least 50% on the theory component (weekly quizzes, tutorials and final exam), in order to pass this course.

University policies

Academic Regulations, Accommodations, Plagiarism

University rules regarding registration, withdrawal, appealing marks, and most anything else you might need to know can be found on the university's website, here:
http://calendar.carleton.ca/undergrad/regulations/academicregulationsoftheuniversity/

Academic Accommodations for Students with Disabilities

The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation.
If you are already registered with the PMC, contact your PMC coordinator to send your *Letter of Accommodation* at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (*if applicable*).
https://carleton.ca/pmc/

For Religious Obligations

Students requesting academic accommodations on the basis of religious obligation should make a formal, written request to their instructors for alternate dates and/or means of satisfying academic requirements. Such requests should be made during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist, but no later than two weeks before the compulsory event.

Accommodation is to be worked out directly and on an individual basis between the student and the instructor(s) involved. Instructors will make accommodations in a way that avoids academic disadvantage to the student. Students or instructors who have questions or want to confirm accommodation eligibility of a religious event or practice may refer to the Equity Services website for a list of holy days and Carleton's Academic Accommodation policies, or may contact an Equity Services Advisor in the Equity Services Department for assistance.

For Pregnancy

Pregnant students requiring academic accommodations are encouraged to contact an Equity Advisor in Equity Services to complete a letter of accommodation. The student must then make an appointment to discuss her needs with the instructor at least two weeks prior to the first academic event in which it is anticipated the accommodation will be required.

Survivors of sexual violence: *As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and where survivors are supported through academic accommodations as per Carleton's Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit carleton.ca/sexual-violence-support.*

Accommodations for student activities: *Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, see the policy.*

You can visit the Equity Services website to view the policies and to obtain more detailed information on academic accommodation at carleton.ca/equity/ .

Plagiarism

Plagiarism is the passing off of someone else's work as your own and is a serious academic offence. For the details of what constitutes plagiarism, the potential penalties and the procedures refer to the section on Instructional Offences in the Undergraduate Calendar.

What are the Penalties for Plagiarism?

A student found to have plagiarized an assignment may be subject to one of several penalties including: expulsion; suspension from all studies at Carleton; suspension from full-time studies; and/or a reprimand; a refusal of permission to continue or to register in a specific degree program; academic probation; award of an FNS, Fail, or an ABS.

Students are expected to familiarize themselves with and follow the Carleton University Student Academic Integrity Policy (see https://carleton.ca/registrar/academic-integrity/). The Policy is strictly enforced and is binding on all students. Plagiarism and cheating – presenting another's ideas, arguments, words or images as your own, using unauthorized material, misrepresentation, fabricating or misrepresenting research data, unauthorized co-operation or collaboration or completing work for another student – weaken the quality of the graduate degree. Academic dishonesty in any form will not be tolerated. Students who infringe the Policy may be subject to one of several penalties including: expulsion; suspension from all studies at Carleton; suspension from full-time studies; a refusal of permission to continue or to register in a specific degree program; academic probation; or a grade of Failure in the course.

Assistance for Students

Academic and Career Development Services: http://carleton.ca/sacds/
Writing Services: http://www.carleton.ca/csas/writing-services/
Peer Assisted Study Sessions (PASS): https://carleton.ca/csas/group-support/pass/
Math Tutorial Centre: https://carleton.ca/math/math-tutorial-centre/
Science Student Success Centre: https://sssc.carleton.ca/