# **Course Outline**: Phys 1004 A/B/C, Winter 2025
# *Introductory Electromagnetism and Wave Motion*

## Course description and prerequisites

This calculus-based course is 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; 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. ***MATH1004 prerequisite will be enforced.***

***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

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|---|---|---|
| Andrew Robinson | PHYS 1004 section A instructor | andrewrobinson@cunet.carleton.ca |
| Emily Heath | PHYS 1004 section B instructor | emilyheath@cunet.carleton.ca |
| Alain Bellerive | PHYS 1004 section C instructor | alainbellerive@cunet.carleton.ca |
| Jesse Lock | Lab & tutorial groups coordinator | jesselock@cunet.carleton.ca |

Material for the lectures, labs and tutorials is available on the course Brightspace page. It is very important that ***each student identifies their 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 new (print for $164.25 or digital for $134.95), or rent (digital for $56.68 ) 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. ***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 6*)<br>Electric field due to discrete charges | **Chap 3:** Vectors (review)<br>**Chap 21:** Coulomb's Law<br>**Chap 22:** Electric fields (part I) | Jan 13 |
| 2 | Electric field due to continuous charge distributions (*week of Jan 13*) | **Chap 22:** Electric fields (part II) | Jan 20 |
| 3 | Gauss' law (*week of Jan 20*) | **Chap 23:** Gauss' Law | Jan 27 |
| 4 | Work and energy (*week of Jan 27*) | **Chap 7:** Kinetic energy and work<br>**Chap 8:** Potential energy and conservation of energy<br>**Chap 24:** Electric potential energy | Feb 3 |
| 5 | Potential energy (*week of Feb 3*) | **Chap 24:** Electric potential energy | Feb 10 |
| 6 | Capacitance (*week of Feb 10*) | **Chap 25:** Capacitance | Feb 24 |
| ***Reading week*** | | | |
| 7 | Magnetic fields (*week of Feb 24*) | **Chap 28:** Magnetic fields | Mar 3 |
| 8 | Magnetic fields (*week of Mar 3*) | **Chap 29:** Magnetic fields due to currents | Mar 10 |
| 9 | Induction (*week of Mar 10*) | **Chap 30:** Induction and Inductance | Mar 17 |
| 10 | AC circuits (*week of Mar 17*) | **Chap 31:** EM oscillations and alternating current | Mar 24 |
| 11 | Maxwell's equations (*week of Mar 24*) | **Chap 32:** Maxwell's equations | Mar 31 |
| 12 | Electromagnetic waves (*week of Mar 31*) | **Chap 33:** Electromagnetic waves | Apr 7 |
| 13 | Review (*week Apr 7*) | | |

## Detailed lecture plan

| Lecture & Test | Topic | Lecture date |
|---|---|---|
| 0 | Pre-lecture reading: Chap 3: Review vectors | |
| 1<br>Test 1 | Chap 21: Coulomb's Law Electric Charge<br>Conductors and Insulators<br>Coulomb's Law<br>Charge Is Quantized and Charge Is Conserved | Jan 6<br>(section C)<br>Jan 7<br>(sections A, B) |
| 2<br>Test 1 | Chap 22: Electric Fields<br>The Electric Field and Electric Field Lines<br>The Electric Field Due to a Point Charge | Jan 8 (C)<br>Jan 9 (A, B) |
| 3<br>Test 2 | Chap 22: cont'd<br>Electric Field Due to an Electric Dipole<br>Electric Field Due to a Line of Charge | Jan 13 (C)<br>Jan 14 (A, B) |
| 4<br>Test 2 | Chap 22: cont'd<br>Electric Field Due to a Ring or Charged Disk<br>A Point Charge in an Electric Field<br>A Dipole in an Electric Field | Jan 15 (C)<br>Jan 16 (A, B) |
| 5<br>Test 2 | Chap 23: Gauss' Law and Electric Flux<br>Flux of an Electric Field<br>Gauss' Law and Coulomb's Law | Jan 20 (C)<br>Jan 21 (A, B) |
| 6<br>Test 2 | Chap 23: cont'd<br>A Charged Isolated Conductor<br>Gauss' Law: Cylindrical Symmetry<br>Gauss' Law: Planar Symmetry<br>Gauss' Law: Cylindrical, Planar and Spherical Symmetries | Jan 22 (C)<br>Jan 23 (A, B) |
| 7<br>Test 3 | Chap 7: Kinetic Energy and Work<br>Chap 8: Potential Energy and Conservation of Energy<br>Work Done on a System by an External Force | Jan 27 (C)<br>Jan 28 (A, B) |
| 8<br>Test 3 | Chap 24: cont'd<br>Potential Due to a Group of Point Charges<br>Potential Due to an Electric Dipole | Jan 29 (C)<br>Jan 30 (A, B) |
| 9<br>Test 3 | Chap 24: cont'd<br>Potential Due to a Continuous Charge Distribution<br>Calculating the Field from the Potential Electric Potential | Feb 3 (C)<br>Feb 4 (A, B) |
| 10<br>Test 3 | Chap 24: cont'd<br>Energy of a System of Point Charges<br>Potential of a Charged Isolated Conductor | Feb 5 (C)<br>Feb 6 (A, B) |
| 11<br>Test 4 | Chap 25: Capacitance<br>Calculating the Capacitance<br>Capacitors in Parallel and in Series<br>Energy Stored in an Electric Field | Feb 10 (C)<br>Feb 11 (A, B) |
| 12<br>Test 4 | Chap 25: cont'd<br>Capacitor with a Dielectric; Atomic View of Dielectrics<br>Dielectrics and Gauss' Law<br>Chap 26: Definition of current as a differential | Feb 12 (C)<br>Feb 13 (A, B) |

| | | |
|---|---|---|
| 13<br>Test 4 | Chap 28: Magnetic Fields<br>What Produces a Magnetic Field? Definition of the B-field<br>Crossed Fields: Discovery of the Electron | Feb 24 (C)<br>Feb 25 (A, B) |
| 14<br>Test 4 | Chap 28 cont'd<br>The Hall Effect<br>A Circulating Charged Particle<br>Magnetic Force on a Wire, Torque on a Current Loop<br>The Magnetic Dipole Moment (*) | Feb 26 (C)<br>Feb 27 (A, B) |
| 15<br>Test 5 | Chap 29: Magnetic Fields due to Currents<br>Force Between Two Parallel Currents<br>Ampere's Law, Solenoids and Toroids<br>A Coil as a Magnetic Dipole | Mar 3 (C)<br>Mar 4 (A, B) |
| 16<br>Test 5 | Chap 29 cont'd<br>Ampere's Law, Solenoids and Toroids<br>A Coil as a Magnetic Dipole | Mar 5 (C)<br>Mar 6 (A, B) |
| 17<br>Test 5 | Chap 30: Induction and Inductance<br>What Is Physics? Two Experiments<br>Faraday's Law of Induction and Lenz's Law<br>Induction and Energy Transfers, Induced Electric Fields | Mar 10 (C)<br>Mar 11 (A, B) |
| 18<br>Test 5 | Chap 30, cont'd<br>Inductors and Inductance, Self-Induction (*)<br>RL Circuits and Energy Stored in a Magnetic Field<br>Energy Density of a Magnetic Field | Mar 12 (C)<br>Mar 13 (A, B) |
| 19 | Chap 31: Electromagnetic Oscillations; Alternating Current<br>LC Oscillations, qualitatively.<br>The Electrical–Mechanical Analogy<br>LC Oscillations, quantitatively. | Mar 17 (C)<br>Mar 18 (A, B) |
| 20 | Chap 31, cont'd<br>Damped Oscillations in RLC Circuit Alternating Current<br>Forced Oscillations<br>Three Simple Circuits and The Series RLC Circuit<br>Power in Alternating-Current Circuits Transformers | Mar 19 (C)<br>Mar 20 (A, B) |
| 21 | Chap 32: Maxwell's Equations<br>Gauss' Law for Magnetic Fields<br>Induced Magnetic Fields | Mar 24 (C)<br>Mar 25 (A, B) |
| 22 | Chap 32, cont'd<br>Displacement Current, Maxwell's Equations | Mar 26 (C)<br>Mar 27 (A, B) |
| 23 | Chap 33: Electromagnetic Waves<br>The Traveling EM Wave, quantitatively<br>Energy Transport and the Poynting Vector, Polarization | Mar 31 (C)<br>Apr 1 (A, B) |
| 24 | Review + catch-up | April 2 (C)<br>April 3 (A, B) |
| 25 | Course review | April 7 (C)<br>April 8 (A, B) |

## 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 two attempts to complete each quiz, and plenty of time to complete each attempt (two hours). The best scoring attempt will be used for grade calculations.

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

Please report any issues with quizzes directly to Dr. Robinson. ***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. $1.60\times10^{-19}$. 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 6, 2025,** 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 the labs. You are not automatically given a lab exemption - you must apply for it no later than **January 24th**. 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 for make-up lab.***

| Week | | Lab section A/C | Lab section B/D |
|---|---|---|---|
| **1** | Jan 6th – 10th | **Tutorial 0:** Introduction (for all sections) | |
| **2** | Jan 13th – 17th | **Lab 1:** Electrostatics | Tutorial 1 |
| **3** | Jan 20th – 24th | Tutorial 1 | **Lab 1:** Electrostatics |
| **4** | Jan 27th - Jan 31st | **Lab 2:** DC Circuit | Tutorial 2 |
| **5** | Feb 3rd – 7th | Tutorial 2 | **Lab 2:** DC Circuit |
| **6** | Feb 10th – 14th | **Lab 3:** Magnetic Balance | Tutorial 3 |
| **7** | Feb 17th – 21st | ***WINTER BREAK*** | |
| **8** | Feb 24th – Feb 28th | Tutorial 3 | **Lab 3:** Magnetic Balance |
| **9** | Mar 3rd – 7th | **Lab 4:** Oscilloscope | Tutorial 4 |
| **10** | Mar 10th – 14th | Tutorial 4 | **Lab 4:** Oscilloscope |
| **11** | Mar 17th – 21st | **Lab 5:** RLC Circuits | Tutorial 5 |
| **12** | Mar 24th – 28th | Tutorial 5 | **Lab 5:** RLC Circuits |
| **13** | Mar 31st – April 4th | **MAKE-UP LABS** | |

***There will be a tutorial on each alternating week with the labs.*** A formula sheet will be provided. The formula sheet will be identical to the one posted on Brightspace. 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 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 Teaching Assistants will demonstrate solving the practice problems and answering questions about the tutorial problem set. **The last hour of the tutorial will be a closed-book test consisting of two multiple choice problems and one long-answer problem (*i.e.* the tutorial test has a duration of 1 hour).**

The grade for the tutorial test long questions and the multiple-choice question 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. There will be no make-up tutorial test and there will be no differed tutorial test.***

Students must attend the tutorial only in the lab section to which they belong.

## 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. The course formula sheet will be provided with the exam. ***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), to pass this course.***

## Mental Health

If you are struggling, please do not hesitate to reach out to your instructors. We are happy to listen, and/or direct you to resources that might help. We will work with you. Remember that Carleton also offers an array of mental health and well-being resources, which can be found here.

# University Policies

In accordance with the Carleton University Undergraduate Calendar Regulations, the letter grades assigned in this course will have the following percentage equivalents:

| | | | |
|---|---|---|---|
| A+ = 90-100 | B+ = 77-79 | C+ = 67-69 | D+ = 57-59 |
| A = 85-89 | B = 73-76 | C = 63-66 | D = 53-56 |
| A- = 80-84 | B- = 70-72 | C- = 60-62 | D- = 50-52 |

F = <50

WDN = Withdrawn from the course

DEF = Deferred

## Academic Accommodations, Regulations, Plagiarism, Etc.

Carleton is committed to providing academic accessibility for all individuals. You may need special arrangements to meet your academic obligations during the term. The accommodation request processes are outlined on the Academic Accommodations website:

https://students.carleton.ca/course-outline/

- **Deferred/missed term work for short-term accommodation (5 days or less)**: Email your instructor.
- **Deferred/missed term work for longer term incapacitation (5 days or longer):** If you require accommodations for this course that are longer than the 5-day (short-term) period, please email your instructor to discuss how/whether accommodation needs could be met for this course.
- **Paul Menton Centre for Students**: The Paul Menton Centre (PMC) is the designated department at Carleton University coordinating disability services on campus. https://carleton.ca/pmc/

## Statement on Chat GPT/Generative AI usage

**AI Use in this course**: Students may use AI tools for basic word processing and formatting functions, including:

- Grammar and spell checking (e.g., Grammarly, Microsoft Word Editor)
- Basic formatting and design suggestions (e.g., Microsoft Word's formatting tools, PowerPoint Design editor)

**Documenting AI Use**: It is not necessary to document the use of AI for the permitted purposes listed above. If you have questions about a specific use of AI that isn't listed above, please consult your instructor.

**Why have we adopted this policy?** This policy ensures that student voices and ideas are prioritized and authentically represented, maintaining the integrity of the work produced by students while allowing basic support to enhance clarity, correctness, layout, and flow of ideas. The goal of adopting a limited use of AI is to help students develop foundational skills in writing and critical thinking by practicing substantive content creation without the support of AI.

# Academic Integrity

Academic Integrity is upholding the values of honesty, trust, respect, fairness, responsibility, and courage that are fundamental to the educational experience. Carleton University provides supports such as academic integrity workshops to ensure, as far as possible, that all students understand the norms and standards of academic integrity that we expect you to uphold. Your teaching team has a responsibility to ensure that their application of the Academic Integrity Policy upholds the university's collective commitments to fairness, equity, and integrity.

(Adapted from Carleton University's Academic Integrity Policy, 2021).

## Examples of actions that do not adhere to Carleton's Academic Integrity Policy include:

- Plagiarism
- Accessing unauthorized sites for assignments or tests
- Unauthorized collaboration on assignment and exams
- Using artificial intelligence tools such as ChatGPT when your assessment instructions say that it is not permitted

Please review the checklist linked here to ensure you understand your responsibilities as a student with respect to academic integrity and this course.

## Sanctions for Not Abiding by Carleton's Academic Integrity Policy

A student who has not upheld their responsibilities under Carleton's Academic Integrity Policy may be subject to one of several sanctions. A list of standard sanctions in science can be found here.

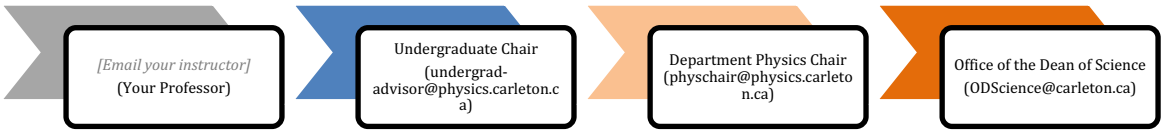
Additional details about this process can be found on the Faculty of Science Academic Integrity website. Students are expected to familiarize themselves with and follow the Carleton University Student Academic Integrity Policy. The Policy is strictly enforced and is binding on all students.

## Student Rights & Responsibilities

Students are expected to act responsibly and engage respectfully with other students and members of the Carleton and the broader community. See the 7 Rights and Responsibilities Policy for details regarding the expectations of non-academic behaviour of students. Those who participate with another student in the commission of an infraction of this Policy will also be held liable for their actions.

## Student Concerns

If a concern arises regarding this course, **your first point of contact is your instructor**: Email or drop in during student hours and I will do my best to address your concern. If I am unable to address your concern, the next points of contact are (in this order):




**Note:** You can also bring your concerns to Ombuds services.