PHYS 1004, Summer 2026

Introductory Electromagnetism and Wave Motion

Information and Course Outline

(0.500 Credit)

We, the people of the Faculty of Science at Carleton University, acknowledge that our campus is located on the traditional, unceded territories of the Algonquin Anishinabeg people. Miigwetch for your hospitality and stewardship of this territory and the teachings that come from it. We are grateful for this land, the air that we breathe, and the water that sustains us all as well as for the animals, plants and other living beings: these enable us to research, teach, mentor, support, study, and learn. We recognize our responsibility to our natural environment and to reconciliation with Indigenous peoples.

Course Instructor: Mustafa Bahran

How to address me: Professor Bahran

Gender Pronouns: (he/him)

Email: mustafabahran@cunet.carleton.ca

Note: If you have or question or would like to talk with me, you can send an email, visit me during student hours (see below), or approach me after lecture.

Best Ways to be in Touch: in class, via email, or during student hours (office hours)

Student Hours: To be announced in Brightspace announcements section.

Lab Supervisors:
Julie Sutton (she/her)
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Office: HP 3368

Maria Paula Rozo Martinez (she/her)
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Office: HP 3304

Office Location: Herzberg 3412

Class Location: Room: **See BS**

Class Times: M, W, 02:35 pm-3:55 pm

Prerequisites:

Students in this course must normally have **MATH1004** and either have passed or be concurrently registered in **ECOR 1034** Mechanics I - or else have passed PHYS 1003 Introductory Mechanics and Thermodynamics or PHYS 1001 Foundations of Physics I or PHYS 1007 Elementary University Physics I (with a grade of at least B-) or BIT1203 Physics for Photonics I

If you do not have both requirements, you must check with your professor to obtain permission of the Physics Department to take this course. If you withdraw from ECOR 1034 during the term, you will be required to also withdraw from PHYS 1004.

Department/Unit: Physics

Class Web Page:
We will use Brightspace which you can access from https://brighspace.carleton.ca

Important dates and deadlines can be found here:
https://carleton.ca/registrar/registration/dates/academic-dates/, including class suspension for winter break, and statutory holidays.

1. Course Description:

This course is designed to introduce electricity, magnetism, circuits, electromagnetic induction, and electromagnetic waves from a physics perspective for students in engineering programs. The associated laboratory sessions will meet virtually on a weekly basis starting in the first week of the term. Student evaluations will be based on labs, online assignments, and a midterm as well as a final exam.

This calculus-based course introduces electricity, magnetism, oscillations, waves and optics. The laboratory is an essential and autonomous part of the course.
Credit in this course precludes additional credit for PHYS 1002, PHYS 1008 and BIT1204.

It must be said, learning physics is a very active process! Everyone can do it with some effort. You all can do it. You will need to take the lead in this effort. Ask questions whenever you need help! Watching someone else "do physics" does not often do much for you! Once you realize that PHYSICS is really fun as you see it in every day's life then you will know that you have understood it.

2. Course Objectives

We will become familiar with electromagnetic theories, concepts and applications surrounding:

1) Electric Phenomena
   a) Notion and applications of charges
   b) Coulomb force as a function of charge and distance
   c) Electric fields as a function of charge and their influence as the origin of the
   d) Coulomb interaction
   e) Parallel plate system as a source for a uniform E field
   f) Electric potential energy and electric potential
   g) Potential Difference and its connection to Electric fields and Work
   h) Capacitors as devices to store charge and energy.
2) DC and AC Circuits
   a) Currents in a conductor under the influence of a potential difference
   b) EMF and batteries
   c) Resistors
      i) Circuits with multiple resistors – equivalent resistance
      ii) Circuits with multiple EMF's – Kirchhoff's Laws
   d) Circuits with resistors and capacitors in combinations – RC Circuits

e) Sinusoidally varying EMF
    i) Reactance and impedance within an AC circuit
    ii) Effect on Power and current
    iii) Resonance and bandwidth

3) Magnetism
    a) Effect of B field on a moving charge
        i) Right Hand Rule
        ii) Mass Spectrometer
        iii) Velocity Selector
    b) Effect of B field on current in a wire
    c) Moving charge as the source of B fields
    d) B fields around wires
    e) Solenoids
    f) Electromagnetic Induction

4) Electromagnetic Radiation
    a) EM Spectrum and characteristics of EM waves
    b) Wave phenomena
        i) Refraction
        ii) Reflection
        iii) Polarization

Numerical solutions and critical thinking will be utilized and tested through assignments and laboratories. Direct real-world applications are highlighted in lectures, examples and reading from the textbook.
This course will rely heavily on a basic understanding of both differential and integral calculus for the theoretical development of concepts presented. Some topics of advanced calculus may be introduced, though will not be developed in any meaningful way, such as partial derivatives, line integrals and surface integrals.
Additionally, significant practice in problem solving, algebra and scientific computing will be exercised throughout the term. Formula sheets will be provided but knowledge of the meaning and the concepts they reflect will be part of the objectives of the lectures and therefore are the student's responsibility to use in assignment and tests accordingly.
More detail on the relevant chapters from the textbook and the course of these topics within the tentative lecture schedule is given in **section 9** of this outline.

TEXTBOOK: *Fundamentals of Physics, Halliday, Resnick and Walker 9th, 10th or 11th E, Volume 2, Chap 21-44. J. Wiley & Sons. (Available at the Bookstore, University Centre.). Any addition is acceptable used or new.*
Prices (based on last semester): Physical $153.95 / eBook $57.00

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3. A Few Words About Physics

Some students believe that if they can follow the lectures in class, then they have learned physics. This is usually not true. Learning physics is not a spectator sport. To learn physics, a student 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 it by making the effort to understand the material and by solving problems using the principles learned.* The standard requirement in a college class is that you spend two hours outside of class for every hour in class. There is no substitute for spending time learning the material.

More broadly, Physics is an ideal place to learn the art of quantitative thinking: to learn how to turn a concept in words into something that one can calculate and measure. In order to solve a problem, you must critically examine the information available in a given situation; determine an effective method to approach the problem, and carry through to the solution, including a critical examination of the final answer to see if it is reasonable. These skills will serve you throughout your future careers, indeed throughout your life. 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 critical thinking and hence helps develop independence and free thinking. An understanding of physics may help you perceive the world around you in a more comprehensible, enjoyable, and fascinating way.

Finally, learning physics is a highly active process! Everyone can do it with some effort. You all can do it. You will need to take the lead in this effort. Ask questions whenever you need help! Watching someone else "do physics" does not often do much for you!

4. Course Philosophy

I want you to enjoy PHYS1004. The material we will be covering is fascinating and applicable. Its implications can be observed in almost everything you interact with every day and certainly very relevant to your careers. In order to make this class as interesting and useful as possible, I will need to get feedback from you. Please feel free to ask questions in class and to come by my office during office hours. As stated earlier, you can only learn physics by personally interacting with the material and solving problems. Consequently, I emphasize three methods of learning in this class:

1. Reading and thinking about the assigned material **before** it is discussed in class.
2. Solving problems using physics concepts and principles, including specific problem-solving techniques.
3. Discussing the material and solving problems in class, including working with your classmates during tutorials.

Thinking about problems and solving them on a regular basis will allow you to learn and appreciate the subject matter in a natural way, without having to cram everything at the last moment.

5. Tests and Assignments

5.1 Brightspace Homework Assignments (HWs)

There will be 6 online HW assignments that will be used as part of the overall term marks. These will be administered through Brightspace and can be accessed through the Assignments section. The assignments will be based on material studied during the lectures during that week. Each HW assignments will be available for a full week for students to solve. Be vigilant and be sure to always check the due dates on the list. There will be 6 assignments; the actual date and times are to be determined at the beginning of the term. Students are allowed 2 attempts for each assignment. If there is any discrepancy between the marks posted in Brightspace grade and your calculated values notify the instructor immediately.

Questions:

Before starting each assignment, first read the relevant chapter(s) in the textbook. Each assignment will consist of calculation-based questions for which you will be given 60 minutes to answer. You will be given 2 attempts at each assignment before the posted deadline, no additional attempts will be allowed following the deadline, with the highest mark of the two attempts taken as the mark for that assignment. Questions have randomized choices of input variable values, so that no two attempts are likely to repeat the same question set.

Numerical Answers:

In answering the assignment calculation questions enter the answer when appropriate in scientific notation with three significant figures e.g 1.60×10^{-19}. You are allowed a 5% variance between your answer and the one calculated within Brightspace to account for round errors, and so on. If you do not answer with three significant figures your answer will be outside of this 5% threshold and will therefore be marked as incorrect. Answers of this sort will not be eligible for reassessment by the professor.

Be sure always to take careful note of the units for your answer, typically it is expected that the answer will follow SI units (m, s, J, etc.) however there are occasions in with non-standard units will be required for the specific question. Generally, these instances will be noted in the question itself, e.g. “Express your answer in km”. Also, units are not to be entered with the numerical answer for these assignments!

Scientific Calculators:

It is highly recommended that you use and understand the functionality of a reliable scientific calculator for all calculations on assignments and tests. In particular, it is good practice to fully understand how to use the scientific notation functionality that all scientific calculators will have available. This will save a great deal of time in all your calculations and greatly reduce mistakes. There are a number of additional functions (such as tabbed results) which can be beneficial in performing calculations.

5.2 Brightspace Pre-Class Quizzes (RQs)

As a weekly online assignments through Brightspace, there will be a pre-class reading quiz (RQ) due before each lecture for a new chapter. The quiz will consist of 5-10 multiple choice questions with a 45–60-minute time limit. There will only be one attempt at these quizzes and all quizzes will count toward the final grade. The questions will be conceptually based. Students must read the relevant chapter and take the RQ prior to the lecture covering the said chapter.

5.3 Mid Term and Final Examination

There will be a midterm in person exam worth 10% of the course. The time and place for the midterm will be announced in due time. Final examination will in person exam worth 25% of the course. It will be scheduled during the regular examination period, at the end of the term. The final exam will be a cumulative covering all sections and chapters studied during the lectures. Students must write the final exam to pass the course. The exam will not include material from the laboratory manual.

6 GRADING

6.1 Grade Structure:

Your grades will be based on all of the course components discussed earlier. **All work must be turned in on time to receive credit.** Your final grade will be based on the points shown below. This chart may be modified at the discretion of the professor. Any modifications will be announced to the class.

Assignment	Total number	How many will be dropped	Points per assignment	Total possible score
Reading	13	3	1	10
Homework	6	1	4	20
Midterm	1	0	10	10
Final	1	0	25	25
Total Theory			65	65
Lab Experiments	5	0		35
Total course	----------	----------	----------	100

If you have any questions about the grade on a particular assignment, you should discuss your questions with the professor *within two weeks after the graded assignment has been posted.* Assignments will not be discussed after this two-week period unless an actual error has been made in grading.

6.2 CONDITION AND GUARANTEED GRADE OF C

1 **Passing Condition**:

In order to pass the course, students must meet the following conditions:

An overall mark must be ***greater than 50%***, AND

Must achieve ***40% or above*** on *BOTH* the Theory (≥ 26/65 marks) *AND*

the Lab (≥ 14/35 marks) components of the course. Achieving more the 40% but less than 50% in either Lab or Theory while achieving 50% or more overall will translate into a grade of D-.

(**NOTE:** Theory includes Assignments, Reading Quizzes, Midterm, and the Final Exam)

Final Exam must be attempted to pass the course, even if you manage to achieve 50% overall mark without the final exam. You must write the midterm and final exams in order to pass the course.

2 You can earn a guaranteed grade of "C" by following **all** the criteria listed below:
   1 Turn in **all** assignments on time. (This includes all reading assignments, homework, and discussion problems.
   2 Earn at least 75-80% of the points available in each category of assignments, except exams. (i.e., earn 75-80% of the points available for reading questions, 75-80% of the points available for group problems, and 75-80% of the points available for homework, 75-80% of the points available for the Lab, respectively.)
   3 Take all exams and maintain at least a "60%" average.

6.3 Grade Definition:

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
ABS = Student absent from final exam
DEF = Deferred (See above)

6.4 Summary of Grade Breakdown

COMPONENT	GRADE VALUE	DATE
READING QUIZZES	10 %	
HOMEWORKS	20 %	
LABS	35 %	
MIDTERM	10%	
FINAL EXAM	25 %	

7 Academic Accommodations and Regulations

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/).

Statement on Chat GPT/Generative AI usage (See the *Sample Syllabus Statements for AI use in Courses* document for examples)

As our understanding of the uses of AI and its relationship to student work and academic integrity continue to evolve, students are required to discuss their use of AI in any circumstance not described here with the course instructor to ensure it supports the learning goals for the course.

Statement on Academic Integrity

Students are expected to uphold the values of academic integrity, which include fairness, honesty, trust, and responsibility. Examples of actions that that compromise these values include but are not limited to plagiarism, accessing unauthorized sites for assignments or tests, unauthorized collaboration on assignments or exams, and using artificial intelligence tools such as ChatGPT when your assessment instructions say it is not permitted.

Misconduct in scholarly activity will not be tolerated and will result in consequences as outlined in Carleton University's Academic Integrity Policy. A list of standard sanctions in the Faculty of 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 abide by Carleton University's Academic Integrity Policy.

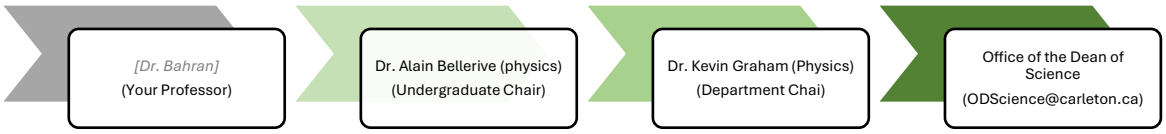
Student Rights & Responsibilities

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 me**: 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.



8 Outline Changes

The professor may occasionally make changes or corrections to the content of this outline. All changes or corrections will be announced on the class web page.

9 CALENDAR AND CHAPTERS COVERED

This schedule of lectures is subject to moderate changes as the semester progresses. RQs are available at least 3 days before due time and HWs are available one week before due time. Day

Date	**Topic(s)**
May 06	Introduction and Ch 21 – Coulomb's Law **RQ1 is due May 6.**
May 11-13	Ch 21, Ch 22 – Electric Fields **RQ2 is due May 13.**
May 18	**Statutory Holyday**
May 20	Ch 22
May 25-27	Ch 23 – Gauss' Law **RQ3 is due May 25, HW1 is due May 25.**
June 01- 03	Ch 24 – Electric Potential **RQ4 is due June 01. HW2 is due June 01.**
June 08 - 10	Ch 25 – Capacitance **RQ5 is due June 08.**
June 15 - 17	Ch 26 – Current and Resistance **RQ6 is due June 15**
June 22-26	**No classes (Early summer exam period)**
June 29	Ch 27 – Circuits **RQ7 is due Jun 29.**
Jul 01	**Statutory Holyday**
Jul 02 (**Thursday**)	**Midterm covering chapters 21 to 26**
Jul 06-08	Ch 27, Ch 28 – Magnetic Fields **RQ8 is due Jul 08. HW3 is due Jul 08.**
Jul 13-15	Ch28, Ch 29 – Magnetic Fields due to Currents **RQ 9 is due Jul 15.**
Jul 20-22	Ch 29, Ch 30 – Induction **RQ10 is due Jul 22. HW4 is due Jul 22.**
Jul 27-29	Ch 30, Ch 31 – Electromagnetic Oscillations and Alternating Current **RQ 11 is due Jul 29.**
Aug 03	**Statutory Holyday**
Aug 05	Ch 31
Aug 10-12	Ch 32 – Maxwell's Equations **RQ 12 is due Aug 10. HW 5 is due Aug 10.**
Aug 14 following Monday schedule)	Ch 33 – Electromagnetic Waves **RQ 13 is due Aug 14.** **HW 6 is due Aug 16.**

10 Lab Outline:

Location: Herzberg Laboratories, HP4130

Lab Sections: A1 - Tuesday, 8:35 to 11:25 am
A2 - Thursday, 1:05 to 3:55 pm

Lab sessions start on the week of **May 11th, 2026**. The format of the laboratories will be in person, no online alternatives will be provided under any circumstances. Please verify your registration on Carleton Central and only attend the section you are registered in.

Attendance to each lab and submission of lab work for each experiment is required as a passing condition for each experiment. If you have a documented reason for missing a laboratory session, you must contact your lab supervisor immediately. A make-up session may be arranged in these cases. If you do not have valid justification, you will not be permitted to take a makeup session, and you will receive a mark of zero for that experiment.

For students repeating this course, you may request to be exempt from the lab (and have your lab mark carried forward from before) if you have completed all the lab experiments with an acceptable lab mark. You must contact your lab supervisor no later than **May 15th, 2026** to obtain explicit permission to be exempt from the lab.

Lab Schedule:

Week of	Experiment	Assessment Format	Weight
May 4th, 2026	No labs scheduled (first week of class)		
May 11th, 2026	**Introduction Session:** Measurements, errors, and graphical analysis	In-class activity	2% (Bonus)
May 18th, 2026	**Lab 1:** Electrostatics	Lab Report	15%
May 25th, 2026			
June 1st, 2026	**Lab 2:** DC Circuits	Lab Report	20%
June 8th, 2026			
June 15th, 2026	**Section A1:** Lab report writing help session **Section A2:** No labs scheduled (Monday schedule on June 18)	In-class activity	2% (Bonus)
June 22nd, 2026	Mid–Summer examinations (No labs scheduled)		
June 29th, 2026	**Section A1:** No labs scheduled **Section A2:** Lab report writing help session	In-class activity	2% (Bonus)
July 6th, 2026	**Lab 3:** Oscilloscope	Lab Report	25%
July 13th, 2026			

July 20th, 2026 July 27th, 2026	**Lab 4:** Magnetic Balance	Lab Report	25%
Aug 3rd, 2026	**Lab 5:** RC/RLC Circuits	Write-up Sheet (in-class)	15%
Aug 10th, 2026	Make-up labs		

Relevant documentation for each experiment will be posted on the labs Brightspace page one week prior to the scheduled lab session.

The final grade for each experiment is calculated as a weighted average of the data upload (worth 15%) and a written laboratory report (worth 85%). For each lab, data and experimental observations must be submitted upon completion of the measurements. Lab reports must be handed in at the end of the second lab session (except for Lab 5, which is an in-class write-up due at the end of the lab session).

All laboratory reports count towards your total lab grade for the course. No experiment grade will be dropped.

Late labs will be accepted up to one week after the due date and with a 20% penalty. Any reports submitted more than one week late will not be accepted. Any in-class activity is due at the end of that lab session, no late submissions will be accepted for grading.