

# ELEC 3909 Course Outline Fall 2022: Electromagnetic Waves

**Course Contents:** Maxwell's equations and EM wave solutions. Polarization. Poynting vector. EM waves in dielectrics and conductors; skin depth. Reflection and refraction. Standing waves. Fresnel relations, Brewster angle. Transmission lines. Line termination, basic impedance matching and transformation. Smith charts. Introduction to guided waves; slab waveguide.

**Prerequisite:** ELEC 3105 or permission of the Department.

**Lectures:** 2 lectures every week, ME3269, [Tuesday and Thursday 1h05-2h25pm](#)

**Problem analysis:** 3 hours every alternate week (for each section).

**Instructor:** Shulabh GUPTA, Mackenzie Building, room 4160 (office) [shulabh.gupta@carleton.ca](mailto:shulabh.gupta@carleton.ca)

**Office hours:** Questions by Brightspace Forum.

**Teaching Assistants:** **Jordan Dugan** ([JordanDugan@cmail.carleton.ca](mailto:JordanDugan@cmail.carleton.ca)) **L2E**

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**Course Format:** The lectures/PA sessions are offered **in-person** only.

## 1. Marking scheme:

**1 Final exam (During normal exam period): weight 50%** but you need to pass the final exam with at least 50% to pass the course

- The Final exam will be scheduled during examination period at the end of the Summer term. Rules for a missed final exam are covered in Carleton's undergraduate calendar.
- The final exam will be traditional 3 hour closed book format and in-person in campus.
- The final exam is exclusively for the purpose of evaluating student performance and will not be returned.
- Students who miss the final exam may be granted permission to write a deferred examination. See the Undergraduate Calendar for regulations on deferred examinations.

**1 Midterm: weight 20%** of the final grade (1 x 20%)

- Midterm will occur during the *5th PA session* and will be in-person. Midterm will be open-book for all. See below the PA session schedule.
- 1st and 3rd PA sessions will be reserved for tutorial on **Ansys High Frequency System Simulator (HFSS), MATLAB, Latex (Overleaf)**.
- Missing a Midterm without a valid reason (medical certificate) will result in a mark of zero. If you know in advance that you cannot attend the Midterm, and can support it with a valid reason, then we can possibly arrange for an accommodation.
- Midterm is open book format. You are free to bring whatever textbook material you think will help you in answering your questions.
- No discussions between students allowed. Any evidence of discussions, cheating, or something similar, during both the final exams or Midterm, will have serious consequences.
- Students registered in their own PA sessions only will be allowed to attend the Midterm. No switching allowed.

**Assignments: total weight of 30% of the final grade (15% + 15%)**

- There will be total two (2) assignments in the entire term, which will be posted on CuLearn at least **2 weeks** before the respective submission deadlines.
- The document must be prepared using **Latex only using the templates provided and submitted as a pdf file, in standard IEEE format**, with suggested section headings and specified page limits. Latex template will be provided in advance. Any submissions not following the IEEE format, will not be accepted.
- The prepared document must be electronically submitted on Brightspace by: **November 1st, 2022 (Set 1)** and **December 8th, 2022 (Set 2)**.
- While you are free to discuss the problem with your colleagues, the final submitted document must be prepared by you.
- Assignment documents must be named according to the following format: `Lastname_Firstname_ELEC_3909_Fall_2022_Assignment_#.pdf`, where # is 1 or 2, depending on the assignment number. Proper naming conventions and file formatting will be strictly enforced for proper organization of the material. Any submission not following these rules will not be marked and returned to the student.
- Assignment set 1 will be returned with feedback after markings, however assignment set 2 is exclusively for the purpose of evaluating student performance and will not be returned.
- Both assignments can be done in pairs or individually.

## 2. Satisfactory performance to pass the course:

- 1- Minimum term course grade of 50% AND
- 2- Minimum grade of 50% in final exam.

Students must review their assignment and quiz grades as soon as they are given back to them. Any marking concerns, and clarifications must first be directly addressed to the TAs. In case, TA's clarifications are not sufficient or students are not satisfied with their markings, they must bring this to my attention as soon as possible. I will treat such instances as an informal appeal and will review/re-mark the quizzes/assignments in question. All such cases, must be brought to me before **December 8th, 2022**.

## 3. Academic Accommodation

You may need special arrangements to meet your academic obligations during the term because of disability, pregnancy or religious obligations. Please review the course outline promptly and write to me with any requests for academic accommodation as soon as possible after the need for accommodation is known to exist. Students with disabilities requiring academic accommodations in this course must register with the Paul Menton Centre for Students with Disabilities (PMC) for a formal evaluation of disability-related needs. Documented disabilities could include but not limited to mobility/physical impairments, specific Learning Disabilities (LD), psychiatric/psychological disabilities, sensory disabilities, Attention Deficit Hyperactivity Disorder (ADHD), and chronic medical conditions. Registered PMC students are required to contact the PMC, 613-520-6608, every term to ensure that your Instructor receives your Letter of Accommodation, no later than two weeks before the first assignment is due or the first in-class test/midterm requiring accommodations. If you only require accommodations for your formally scheduled exam(s) in this course, please submit your request for accommodations to PMC by the last official day to withdraw from classes in each term.

## 4. PA sessions (for each section)

**Session #1: Introduction to Ansys HFSS & plane-wave propagation modeling, Latex & overleaf. [AP332]**

**Session #2: Problem Analysis Session + Assignment #1 discussion**

**Session #3: Problem Analysis**

**Session #4: Ansys HFSS tutorial on Transmission Lines and Waveguides [AP332]**

**Session #5: Assignment #2 discussion + 2 hour Midterm**

**Session #6: Problem Analysis**

**Note 1:** Session #1 and #3 will be held in **AP332** (Azreili Pavilion). **These two sessions are mandatory**, and attendance will be taken. Penalty of 5% of the total grade will be applied per session for missing each session.

**Note 2:** HFSS tutorials conducted in Session #1 and Session #4 will be recorded and will be posted on Brightspace for the entire duration of the course.

**Note 3:** All HFSS/Assignment/lecture related questions **must be posted on Brightspace forum only**, to avoid repetitions and so that everyone benefits. In certain cases, questions can be emailed to me or the TAs.

**Note 4:** The PA session will be used to answer your questions and do sample problems (total 5 problem sets) with the Teaching assistants. The purpose of the PA session is to go over the solutions to some of the suggested problems. It is expected that each student would have attempted the problems prior to the commencement of the PA session. **Only the Final answers will be provided for selected problems.**

**Note 5:** While the attendance during the lectures and general PA sessions is not mandatory, a general attendance will be taken in all course sessions for information only.

## 5. Textbooks and other learning resources

There are no official textbook for this course. However, some suggested textbooks covering the course contents are:

1. M. Sadiku, "Elements of Electromagnetics", 6th edition (recommended)
2. Branislav M. Notaros, "Electromagnetics," (Prentice Hall, 2011).
3. David J. Griffith, "Introduction to Electrodynamics", Pearson.

I will be using slides in classes. Additional material will be used to reinforce the understanding. Several good textbooks covers Electromagnetics and studying from them outside lecture hours is strongly recommended: **If you were to attempt to study and pass the final exam by using only the lecture slides, you would likely fail the course.** The lecture slides will be available to you after every lecture, however.

**Note: If there are any important changes, they will be communicated to you, well in advance.**

## 6. Professional Engineering Accreditation Requirements

**Graduate Attributes:** An institution must demonstrate that graduates of its programs possess the attributes described below. In addition, the institution must implement and employ processes to demonstrate that program outcomes are being assessed in the context of these attributes, and that the results of such assessments will be applied to the further development of programs. The graduate attributes are:

1. **A knowledge base for engineering:** Demonstrated competence in university level mathematics, natural sciences, engineering fundamentals, and specialized engineering knowledge appropriate to the program.
2. **Problem analysis:** An ability to use appropriate knowledge and skills to identify, formulate, analyze, and solve complex engineering problems in order to reach substantiated conclusions.
3. **Investigation:** An ability to conduct investigations of complex problems by methods that include appropriate experiments, analysis and interpretation of data, and synthesis of information in order to reach valid conclusions.
4. **Design:** An ability to design solutions for complex, open-ended engineering problems and to design systems, components or processes that meet specified needs with appropriate attention to health and safety risks, applicable standards, and economic, environmental, cultural and societal considerations.
5. **Use of engineering tools:** An ability to create, select, apply, adapt, and extend appropriate techniques, resources, and modern engineering tools to a range of engineering activities, from simple to complex, with an understanding of the associated limitations.
6. **Individual and team work:** An ability to work effectively as a member and leader in teams, preferably in a multi-disciplinary setting.
7. **Communication skills:** An ability to communicate complex engineering concepts within the profession and with society at large. Such ability includes reading, writing, speaking and listening, and the ability to comprehend and write effective reports and design documentation, and to give and effectively respond to clear instructions.
8. **Professionalism:** An understanding of the roles and responsibilities of the professional engineer in society, especially the primary role of protection of the public and the public interest.
9. **Impact of engineering on society and the environment:** Impact of engineering on society and the environment: An ability to analyze social and environmental aspects of engineering activities. Such ability includes an understanding of the interactions that engineering has with the economic, social, health, safety, legal, and cultural aspects of society, the uncertainties in the prediction of such interactions; and the concepts of sustainable design and development and environmental stewardship.
10. **Ethics and equity:** An ability to apply professional ethics, accountability, and equity.
11. **Economics and project management:** An ability to appropriately incorporate economics and business practices including project, risk, and change management into the practice of engineering and to understand their limitations.
12. **Life-long learning:** An ability to identify and to address their own educational needs in a changing world in ways sufficient to maintain their competence and to allow them to contribute to the advancement of knowledge.

This course (ELEC 3909) will score attributes 1.6.E - Knowledge base: Discipline-specific concept DOE-3: Electromagnetics, 2.1 - Problem analysis: Problem definition, 2.2 - Problem analysis: Approach to the problem, 2.3 - Problem analysis: Use of assumptions, 2.4 - Problem analysis: Interpreting the solution - validity of results, 4.1 - Design: Clear design goals, 4.2 - Design: Detailed design specifications and requirements, 4.4 - Design: Design solution(s), 4.5 - Design: Design implementation / task(s) definition, 4.6 - Design: Alternate solution(s) definition, 4.7 - Design: Evaluation based on engineering principles. They are scored through the responses provided in assignments, quizzes, pre-lab and lab reports, presentations, final exams. The graduate attribute scores may in some cases be derived from graded material, however the graduate attribute scores are not used in determination of the final grade for the course.

## 7. OTHER important issue: COPYRIGHT:

“I would like to remind you that my lectures and course materials, including power point presentations, outlines, and similar materials, are protected by copyright. I am the exclusive owner of copyright and intellectual property in the course materials. You may take notes and make copies of course materials for your own educational use. You may not and may not allow others to reproduce or distribute lecture notes and course materials publicly for commercial purposes without my express written consent.”

## 8. COVID Protocols

It is important to remember that COVID is still present in Ottawa. The situation can change at any time and the risks of new variants and outbreaks are very real. There are a number of actions you can take to lower your risk and the risk you pose to those around you including being vaccinated, wearing a mask, staying home when you're sick, washing your hands and maintaining proper respiratory and cough etiquette.

**Feeling sick?** Remaining vigilant and not attending work or school when sick or with symptoms is critically important. If you feel ill or exhibit COVID-19 symptoms do not come to class or campus. If you feel ill or exhibit symptoms while on campus or in class, please leave campus immediately. In all situations, you must follow Carleton's symptom reporting protocols.

**Masks:** Carleton has paused the COVID-19 Mask Policy, but continues to strongly recommend masking when indoors, particularly if physical distancing cannot be maintained. It may become necessary to quickly reinstate the mask requirement if pandemic circumstances were to change.

**Vaccines:** Further, while proof of vaccination is no longer required as of May 1 to attend campus or in-person activity, it may become necessary for the University to bring back proof of vaccination requirements on short notice if the situation and public health advice changes. Students are strongly encouraged to get a full course of vaccination, including booster doses as soon as they are eligible, and submit their booster dose information in cuScreen as soon as possible. Please note that Carleton cannot guarantee that it will be able to offer virtual or hybrid learning options for those who are unable to attend the campus.

All members of the Carleton community are required to follow requirements and guidelines regarding health and safety which may change from time to time. For the most recent information about Carleton's COVID-19 response and health and safety requirements please see the University's COVID-19 website and review the Frequently Asked Questions (FAQs). Should you have additional questions after reviewing, please contact [covidinfo@carleton.ca](mailto:covidinfo@carleton.ca).