

# ELEC 3909 COURSE OUTLINE WINTER 2023: 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's 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:** Twice a week: [Tuesday and Thursday 18h35-19h55 AT101](#)

**Problem analysis:** three hours every alternate week.

**Instructor:** Khaled Mnaymneh, [khaled.mnaymneh@carleton.ca](mailto:khaled.mnaymneh@carleton.ca)

**Office hours:** email for appointments

Textbooks for this course are:

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

**IMPORTANT:** I will be using both slides and board work in classes. Several good textbooks covers electromagnetics and **studying from them outside lecture hours is strongly recommended. If you were to attempt to study and write 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. **Tips to pass (and even do well): make use of your TAs' time; do lots of problems from textbooks; you may even need to hire your own tutor, if need be - having a solid understanding of the math will allow you to wield the appropriate equations effectively against any problem**

## Teaching Assistants:

Jorden Labossiere ([jordenlabossiere@cmail.carleton.ca](mailto:jordenlabossiere@cmail.carleton.ca)) – TA for L1O and L5O

Keigan Macdonell ([KeiganMacdonell@cmail.carleton.ca](mailto:KeiganMacdonell@cmail.carleton.ca)) – TA for L3O and L4E

Yousef Karimi Yonjali ([YousefKarimiYonjali@cmail.carleton.ca](mailto:YousefKarimiYonjali@cmail.carleton.ca)) – TA for L2E

Mohamed Emara ([mohamedemara@cmail.carleton.ca](mailto:mohamedemara@cmail.carleton.ca)) – TA for office hours (Mondays, 2 pm to 4 pm, ME 5128; and by email appointment as well)

## 1. Marking scheme:

**1 Final exam (During normal exam period): weight 60%** everyone gets to write the final exam 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 winter term; rules for a missed final exam are covered in Carleton's undergraduate calendar
- the final exam will be closed book, unless otherwise announced, before the final exam; a single page hand-written (A4 size, back and front) will be allowed as the cheatsheet, that students must prepare themselves; only a designated standard calculator, will be allowed in the exam; any cellphones, computers, electronics items or books will be strictly prohibited
- 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

**4 Quizzes (best 4 out of 5): quizzes will count for 40%** of the final grade (4 x 10%)

- quizzes will occur during the last hour of each PA session (except the first one)
- prior to the start of the quiz, the TA will have each student present sign the attendance sheet; a check mark next to each name will be added when you hand in your quiz; (similar to the attendance format for final exams)
- missing a quiz without a valid reason (medical certificate) will result in a mark of zero for that quiz; if you know in advance that you cannot attend a quiz, and can support it with a valid reason, then we can possibly arrange for an accommodation
- quizzes are open book format; you are free to bring whatever textbook material you think will help you in answering your questions; however, no electronics, such as cell phones, computers etc. will be allowed
- each quiz will be divided into 2 parts: multiple choice and subjective questions; instructions to complete the quiz will be clearly mentioned in the quiz itself
- no discussions between students allowed; any evidence of discussions, cheating, or something similar, during both the final exams or quizzes, will have serious consequence

## 2. Satisfactory performance to pass the course:

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

Students must review their 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 April 7, 2023.

## 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

The first 2 hours of each PA session will be used to answer your questions and do sample problems with the Teaching assistants. In the last hour of the PA there will be a quiz. No quiz on the 1st PA session. The purpose of the PA session is to go over the solutions to some of the suggested problems. Don't expect the TA to solve all the assigned questions. It is expected that each student would have tried and solved most of the questions prior to the commencement of the PA session. Final answers will be provided for selected problems.

## 5. 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 multidisciplinary 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.

#### **6. 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."