

**ELEC ENG 3FH4  
Electromagnetics I**

**COURSE OUTLINE**

Please refer to course website for updated information.

**COURSE DESCRIPTION**

Mathematical foundations of electromagnetics (selected topics of vector calculus); electrostatics, magnetostatics and conduction; introduction to time-varying fields through Faraday's law.

Three lectures, two tutorials; second term

Instructor: Mohamed Bakr

**PRE-REQUISITES AND ANTI-REQUISITES**

Pre-requisite(s): ELECENG 2CI5 or 2CI4 and PHYSICS 1E03, registration in Electrical Engineering or the Integrated Biomedical Engineering and Health Sciences (IBEHS) Program

**SCHEDULE and MODE OF DELIVERY**

The material for this course will be delivered through a mixture of online videos, textbook readings, live lectures, and tutorials.

Lecture: Monday, Wednesday, and Thursday, 1:30 pm – 2:20 pm

Tutorial: Wednesday and Thursday, 10:30 am – 11:20 am

**INSTRUCTOR**

Dr. Mohamed Bakr

E-mail: mbakr@mcmaster.ca

Office: ITB-A111

Phone: 905-525-9140 ext. 27532

Office Hours: By appointment on Microsoft Teams

**TEACHING ASSISTANTS**

Names, contact information, and office hours are provided on the course website

**COURSE WEBSITE/S**

<http://avenue.mcmaster.ca>

**COURSE OBJECTIVES**

By the end of this course, students should be able to demonstrate their competency and be knowledgeable on:

- Ability to link the electric field strength and orientation to the distance to charge distributions and charge configurations or distributions (Indicators 1.2, 1.3).
- Ability to link the magnetic field strength and orientation to the distance of electric current configurations or distributions (Indicators 1.2, 1.3).
- Understanding the field theoretical origins of Kirchhoff's voltage and current laws and these laws' limitation when applied to high-frequency fields (Indicators 1.2, 1.3, 2.1).
- Understanding the principle of superposition and the difference between the superposition of scalar field quantities and that of vectorial field quantities (Indicators 1.2, 1.3).
- Understanding the limitations of the superposition principle as applicable to linear media only (Indicators 1.3, 2.1.)
- Understanding the impact of metals on static electric fields and the use of metals for shielding and electrical isolation (Indicators 1.3, 2.1).
- Understanding the phenomenon of dielectric polarization and ability to predict the capacitance of simple structures (Indicators 1.2, 1.3).
- Understanding the phenomenon of electrical conduction and the concept of resistance (or conductance). Understanding the difference between conductors and superconductors. Ability to predict the resistance of simple structures (Indicators 1.2, 1.3).
- Basic understanding of the interaction of the electric and magnetic field with matter and the concepts of heterogeneity, anisotropy and nonlinearity (Indicators 1.2, 1.3).
- Understanding the fundamental importance of the conservation of charge and its implications in circuit analysis and charge relaxation (Indicators 1.2, 1.3).
- Understanding the nature of electric energy, magnetic energy, power, and power dissipation (Indicators 1.2, 1.3, 9.1).
- Understanding the link between the electric and magnetic field as the two sides of the same phenomenon, the electromagnetic field (Indicators 1.2).
- Ability to apply vector calculus to the solution of simple electric and magnetic analysis in the three basic orthogonal coordinate systems: rectangular, spherical, and cylindrical (Indicators 1.2, 5.2).

**CEAB GRADUATE ATTRIBUTES (GAs)**

Note: The CEAB Graduate Attributes (GAs) defined in this section are measured throughout the course and form part of the Department's continuous improvement process. They are a key component of the accreditation process for the program and will not be taken into consideration in determining a student's actual grade in the course. For more information on accreditation, please ask your instructor or visit: <http://www.engineerscanada.ca>

Attributes	Indicators		Measurement Method(s)
	Number	Description	
Knowledge Base for Engineering	1.2	Competence in Natural Sciences	Questions in quizzes, midterms, and final
Knowledge Base for Engineering	1.3	Competence in Engineering Fundamentals	Questions in quizzes, midterms, and final
Problem Analysis	2.1	Identifies and states reasonable assumptions and suitable engineering fundamentals, before proposing a solution path to a problem.	Questions in quizzes, midterms, and final
Use of Engineering Tools	5.2	Successfully uses engineering tools.	MATLAB Assignments
Impact of Engineering on Society and the Environment	9.1	Evaluates the environmental impact of engineering activities, identifies uncertainties in decisions, and promotes sustainable design.	Final examination questions

**ASSUMED KNOWLEDGE**

Mathematics: Calculus, basic matrix operations, ordinary differential equations.

Physics: Electric field of a point charge, Coulomb's law, Magnetic field of a straight wire with current, Ampère's law  
 Electrical Engineering: Kirchhoff's laws, resistors, capacitors, inductors

### COURSE MATERIALS

#### Required Texts:

1. Matthew N.O. Sadiku, *Elements of Electromagnetics*, 7<sup>th</sup> edition, Oxford University Press.
2. M.H. Bakr, *Matlab Experiments Manual for EE2FH4*, electronic manual, 2023.

#### Calculator:

Only the McMaster Standard Calculator (Casio fx-991 MS or MS Plus) will be permitted in tests and examinations. This is available at the Campus Store.

#### Other:

Videos available through Dr. Bakr's YouTube Channel:

[http://www.youtube.com/channel/UCFQ\\_5eallhvHplhf9pdsVsw](http://www.youtube.com/channel/UCFQ_5eallhvHplhf9pdsVsw)

### COURSE OVERVIEW

Week	Topic	Readings	Week
1	Vector Algebra	Text Chs. 1 and 2, lecture notes	1
2	Vector Calculus	Text Ch. 3, lecture notes	2
3	Vector Calculus	Text Ch. 3, lecture notes	3
4	Electrostatic Fields	Text Ch. 4, lecture notes	4
5	Electrostatic Fields	Text Ch. 4, lecture notes	5
6	Fields in Different Materials	Text Ch. 5, lecture notes	6
7	Electrostatic Boundary Value Problems	Text Ch. 6, lecture notes	7
8	Magnetostatic Fields	Text Ch. 7, lecture notes	8
9	Magnetic Forces and Materials	Text Ch. 8, lecture notes	9
10	Magnetic Materials and Inductances	Text Ch. 8, lecture notes	10
11	Maxwell's Equations	Text Ch. 9, lecture notes	11

A more detailed timeline is available on the course website.

At certain points in the course, it may make good sense to modify the schedule. The Instructor may modify elements of the course and will notify students accordingly (in class and on the course website).

<b>ASSESSMENT</b>
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<b>Component</b>	<b>Weight</b>
Vector Calculus Test	10%
First Midterm	10%
Second Midterm	10%
Quizzes	10%
MATLAB Assignments	10%
Final Exam	50%
<b>Total</b>	<b>100%</b>

#### Grading and Evaluation Policies

- There are one vector test, two (2) mid-term exams, and one (1) final exam to be evaluated in this course.
- Use of books, notes, other copied materials, computers or cell phones are not allowed during exams. You are only allowed to use your cheat sheets according to the rules shared on Avenue.
- If you score less than 50% in the final examination's MATLAB question, your MATLAB assignments mark will be set equal to that of your final exam's MATLAB question.

<b>ACADEMIC INTEGRITY</b>
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You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. The academic credentials you earn are rooted in principles of honesty and academic integrity. It is your responsibility to understand what constitutes academic dishonesty.

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g., the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the University. For information on the various types of academic dishonesty, please refer to the Academic Integrity Policy, located at <https://secretariat.mcmaster.ca/university-policies-proceduresguidelines/>

The following illustrates only three forms of academic dishonesty:

- plagiarism, e.g., the submission of work that is not one's own or for which other credit has been obtained.
- improper collaboration in group work.

- copying or using unauthorized aids in tests and examinations.

#### **AUTHENTICITY / PLAGIARISM DETECTION**

Some courses may use a web-based service (Turnitin.com) to reveal authenticity and ownership of student-submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g., A2L, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., online search, other software, etc.). For more details about McMaster's use of Turnitin.com, please go to [www.mcmaster.ca/academicintegrity](http://www.mcmaster.ca/academicintegrity).

#### **COURSES WITH AN ONLINE ELEMENT**

Some courses may use online elements (e.g., email, Avenue to Learn (A2L), LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, user names for the McMaster email accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses online elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure, please discuss this with the course instructor.

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

#### **COPYRIGHT AND RECORDING**

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright-protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical, and artistic work, including lectures by University instructors.

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the Instructor for the purpose of authorized distribution or by a student for the purpose of personal study. Students should be aware that their voice and/or

image may be recorded by others during the class. Please speak with the Instructor if this is a concern for you.

### **CONDUCT EXPECTATIONS**

As a McMaster student, you have the right to experience and the responsibility to demonstrate respectful and dignified interactions within all of our living, learning, and working communities. These expectations are described in the Code of Student Rights & Responsibilities (the "Code"). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, whether in person or online. It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g., use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students' access to these platforms.

### **ACADEMIC ACCOMMODATIONS**

Students with disabilities who require academic accommodation must contact Student Accessibility Services (SAS) at 905-525-9140 ext. 28652 or [sas@mcmaster.ca](mailto:sas@mcmaster.ca) to make arrangements with a Program Coordinator. For further information, consult McMaster University's Academic Accommodation of Students with Disabilities policy.

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students should submit their request to their Faculty Office normally within 10 working days of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

### **REQUESTS FOR RELIEF FOR MISSED ACADEMIC WORK**

McMaster Student Absence Form (MSAF): In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar "Requests for Relief for Missed Academic Term Work".

### **EXTREME CIRCUMSTANCES**

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be

communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.

[www.eng.mcmaster.ca/ece](http://www.eng.mcmaster.ca/ece)

## Electrical and Computer Engineering Lab Safety

### Information for Laboratory Safety and Important Contacts

This document provides important information for the healthy and safe operation of ECE instructional laboratories. This document is required reading for all laboratory supervisors, instructors, researchers, staff, and students working in or managing instructional laboratories in ECE. It is expected that revisions and updates to this document will be done continually. A McMaster University lab manual is also available to read in every laboratory and online <https://hr.mcmaster.ca/app/uploads/2019/07/2019-McMaster-Lab-Manual.pdf>

### General Health and Safety Principles

Good laboratory practice requires that every laboratory worker and supervisor observe the following whether conducting lab work at school or at home:

1. Food and beverages are not permitted in the instructional laboratories.
2. A Laboratory Information Sheet on each lab door identifying potential hazards and emergency contact names should be known.
3. Laboratory equipment should only be used for its designed purpose.
4. Proper and safe use of lab equipment should be known before using it.
5. The course TA leading the lab should be informed of any unsafe conditions.
6. The location and correct use of all available safety equipment should be known.
7. Potential hazards and appropriate safety precautions should be determined, and the sufficiency of existing safety equipment should be confirmed before beginning new operations.
8. Proper waste disposal procedures should be followed.
9. Personal ergonomics should be practiced when conducting lab work. <https://bit.ly/3fOE71E>
10. Current University health and safety issues and protocol should be known. <https://hr.mcmaster.ca/resources/covid19/workplace-health-and-safety-guidance-during-covid-19/>



## Location of Safety Equipment

### Fire Extinguisher

On walls in halls outside of labs

### First Aid Kit

ITB A111, or dial "88" after 4:30 p.m.

### Telephone

On the wall of every lab near the door

### Fire Alarm Pulls

Near all building exit doors on all floors

## Who to Contact

**Emergency Medical / Security:** On McMaster University campus, call Security at extension 88 or 905-522-4135 from a cell phone.

**Non-Emergency Accident or Incident:** Immediately inform the TA on duty or Course Instructor.

**University Security (Enquiries / Non-Emergency):** Dial 24281 on a McMaster phone or dial 905-525-9140 ext. 24281 from a cell phone.

**See TA or Instructor:** For problems with heat, ventilation, fire extinguishers, or immediate repairs

**Environmental & Occupational Health Support Services (EOHSS):** For health and safety questions dial 24352 on a McMaster phone or dial 905-525-9140 ext. 24352 from a cell phone.

**ECE Specific Instructional Laboratory Concerns:** For non-emergency questions specific to the ECE laboratories, please contact 24103.

## In Case of a Fire (On Campus Dial 88)

When calling to report a fire, give name, exact location, and building.

1. Immediately vacate the building via the nearest Exit Route. Do not use elevators!
2. Everyone is responsible for knowing the location of the nearest fire extinguisher, the fire alarm, and the nearest fire escape.
3. The safety of all people in the vicinity of a fire is of foremost importance. But do not endanger yourself!
4. In the event of a fire in your work area shout "*Fire!*" and pull the nearest fire alarm.
5. Do not attempt to extinguish a fire unless you are confident it can be done in a prompt and safe manner utilizing a hand-held fire extinguisher. Use the appropriate fire extinguisher for the specific type of fire. Most labs are equipped with Class A, B, and C extinguishers. Do not attempt to extinguish Class D fires which involve combustible metals such as magnesium, titanium, sodium, potassium, zirconium, lithium, and any other finely divided metals which are oxidizable. Use a fire sand bucket for Class D fires.
6. Do not attempt to fight a major fire on your own.
7. If possible, make sure the room is evacuated; close but do not lock the door and safely exit the building.

## Clothing on Fire

Do not use a fire extinguisher on people

1. Douse with water from safety shower immediately or
2. Roll on floor and scream for help or
3. Wrap with fire blanket to smother flame (a coat or other nonflammable fiber may be used if blanket is unavailable). Do not wrap a standing person; rather, lay the victim down to extinguish the fire. The blanket should be removed once the fire is out to disperse the heat.

## Equipment Failure or Hazard

Failure of equipment may be indicative of a safety hazard - You must report all incidents.

Should you observe excessive heat, excessive noise, damage, and/or abnormal behaviour of the lab equipment:

1. Immediately discontinue use of the equipment.
2. In power labs, press the wall-mounted emergency shut-off button.
3. Inform your TA of the problem.
4. Wait for further instructions from your TA.
5. TA must file an incident report.

## Protocol For Safe Laboratory Practice

Leave equipment in a safe state for the next person - if you're not sure, ask!

In general, leave equipment in a safe state when you finish with it. When in doubt, consult the course TA.

## Defined Roles

TA	The first point of contact for lab supervision	
ECE Lab Supervisor	Steve Spencer - ITB 147	<a href="mailto:steve@mail.ece.mcmaster.ca">steve@mail.ece.mcmaster.ca</a>
ECE Chair	Mohamed Bakr - ITB A111	<a href="mailto:mbakr@mcmaster.ca">mbakr@mcmaster.ca</a>
ECE Administrator	Shelby Gaudrault - ITB A111	<a href="mailto:gaudraus@mcmaster.ca">gaudraus@mcmaster.ca</a>
ECE Course Instructor	Mohamed Bakr – ITB A111	<a href="mailto:mbakr@mcmaster.ca">mbakr@mcmaster.ca</a>