Toronto Metropolitan University

Department of Electrical, Computer, & Biomedical Engineering
Faculty of Engineering & Architectural Science

Course Outline (W2025)

ELE401: Electric and Magnetic Fields

Instructor(s)	Dr. Marco Antoniades [Coordinator] Office: ENG 453 Phone: (416) 979-5000 x 556097 Email: mantoniades@torontomu.ca Office Hours: Wednesdays 1:00 - 2:00 pm by email
Calendar Description	Review of vector analysis and coordinate systems. Coulomb's law and electric field intensity. Gauss's law and electric flux density. The electric potential and potential gradient. Electric fields in material space. Poisson's and Laplace's equations. Capacitance. Biot-Savart's Law and magnetic field intensity. Ampere's circuital law and the magnetic flux density. Magnetic forces. Self and mutual inductances. Time-varying fields and Maxwell's equations.
Prerequisites	MTH 312
Antirequisites	None
Corerequisites	None
Compulsory Text(s):	1. F.T. Ulaby and U. Ravaioli, Fundamentals of Applied Electromagnetics, 8th ed, Pearson, 2020. 2. M.N.O. Sadiku, Elements of Electromagnetics, 7 th edition, Oxford University Press, 2018.
Reference Text(s):	1. W.H. Hayt and J.A. Buck, Engineering Electromagnetics, 8th ed, McGraw-Hill, 2012. 2. D.K. Cheng, Fundamentals of Engineering Electromagnetics, Addison-Wesley, 1993. 3. J.A. Edminister, Theory and Problems of Electromagnetics, 2nd edition, Schaum's Outline Series, McGraw-Hill, 1993.
Learning Objectives (Indicators)	At the end of this course, the successful student will be able to: 1. Demonstrate an in-depth understanding of the physical laws of electricity and magnetism, such as Coulombs law, Gausss laws, Biot-Savarts law, Amperes law, and Faradays law. Apply the laws of electricity and magnetism to realistic engineering problems. (**1a**) 2. Apply vector calculus to analyze engineering problems involving electric and magnetic fields and their sources, charges and currents. Identify and use appropriate coordinate systems (rectangular, cylindrical or spherical), based on given geometries. (**1b**) 3. Identify and apply appropriate electricity and magnetism concepts to solve for relevant field quantities (electric and magnetic fields), terminal quantities (voltages and currents), or electrical engineering parameters (resistance, capacitance or inductance) of different structures. Demonstrate how the interaction of electric and magnetic fields with different media can lead to changes in the properties of materials, including polarization in dielectrics and magnetization in magnetic materials. (**1c**) 4. Given a set of written instructions, illustrate concepts in graphical form. Apply understanding of field principles to provide scalar or vectorial representations of quantities. (**7a**)

	NOTE:*Numbers in parentheses refer to the graduate attributes required by the Canadian Engineering Accreditation Board (CEAB).*
Course Organization	4.0 hours of lecture per week for 13 weeks 2.0 hours of tutorial per week for 12 weeks
Teaching Assistants	Nickolas Papoutsis (nickolas.papoutsis@torontomu.ca) Mahdi Tahmasebi (mtahmasebi@torontomu.ca) Chaitanya Sinha (csinha@torontomu.ca)
Course Evaluation	<table><tr><td>Quizzes</td><td>15 %</td></tr><tr><td>Midterm Exam</td><td>35 %</td></tr><tr><td>Final Exam</td><td>50 %</td></tr><tr><td>TOTAL:</td><td>100 %</td></tr></table> **Note:** In order for a student to pass a course, a minimum overall course mark of 50% must be obtained. In addition, for courses that have both **"Theory and Laboratory"** components, the student must pass the Laboratory and Theory portions separately by achieving a minimum of 50% in the combined Laboratory components and 50% in the combined Theory components. Please refer to the **"Course Evaluation"** section above for details on the Theory and Laboratory components (if applicable).
Examinations	NOTE: This course has only Theory components. Therefore, to pass the course, a student must simply obtain a minimum overall mark of 50%. All quizzes and exams will be carried out in person. Quizzes: Three (3) quizzes, each worth 5%, will be conducted. The dates for the quizzes will be posted on D2L. Each will have a 30 minute duration. Mid-Term Exam: Conducted in Week 8, covers the material from Weeks 1-7. One and a half (1.5) hour duration. Final Exam: Conducted during the final exam period, covers all the material from Weeks 1-13. Three (3) hour duration.
Other Evaluation Information	None
Teaching Methods	1. Lectures will be delivered synchronously (i.e. for all students at the same time) during thescheduled class hours in person, and via Zoom if possible. 2. Notes/slides from the class lectures will be posted on D2L. 3. Lecture recordings will also be posted on D2L.
Other Information	None

Course Content

Week	Hours	Chapters / Section	Topic, description
1	2	1.1 to 1.6	* Chapter sections refer to Ulaby's book unless otherwise noted * Introduction to Electromagnetism
1-2	4	3-1 to 3-7	Review of Vector Analysis
2-7	22	4-1 to 4-11	Electrostatics Maxwell's equations Charge and current distributions Coulomb's law Gauss's law Electric scalar potential Conductors Dielectrics Electric boundary conditions Capacitance Electrostatic potential energy Image method
8	4		Electrostatic Boundary-Value Problems (Sadiku, sections 6.2 to 6.4) Poisson's and Laplace's equations Uniqueness theorem Solutions of Poisson's and Laplace's equations
9-12	14	5-1 to 5-8	Magnetostatics Magnetic forces and torques The Biot-Savart law Gauss's law for magnetism Ampere's law Vector magnetic potential Magnetic properties of materials Magnetic boundary conditions Inductance Magnetic energy
12-13	6	6-1 to 6-7	Maxwell's equations and time-varying fields Faraday's law

			Stationary loop in a time-varying magnetic field The ideal transformer Moving conductor in a static magnetic field The electromagnetic generator Moving conductor in a time-varying magnetic field Displacement current

University Policies & Important Information

Students are reminded that they are required to adhere to all relevant university policies found in their online course shell in D2L and/or on the Senate website

Refer to the Departmental FAQ page for furhter information on common questions.

Important Resources Available at Toronto Metropolitan University

- The Library provides research workshops and individual assistance. If the University is open, there is a Research Help desk on the second floor of the library, or students can use the Library's virtual research help service to speak with a librarian.
- Student Life and Learning Support offers group-based and individual help with writing, math, study skills, and transition support, as well as resources and checklists to support students as online learners.
- You can submit an Academic Consideration Request when an extenuating circumstance has occurred that has significantly impacted your ability to fulfill an academic requirement. You may always visit the Senate website and select the blue radio button on the top right hand side entitled: **Academic Consideration Request (ACR)** to submit this request.

  For Extenuating Circumstances, Policy 167: Academic Consideration allows for a once per semester ACR request without supporting documentation if the absence is less than 3 days in duration and is not for a final exam/final assessment. Absences more than 3 days in duration and those that involve a final exam/final assessment, require documentation. Students must notify their instructor once a request for academic consideration is submitted. See Senate Policy 167: Academic Consideration.
- If taking a remote course, familiarize yourself with the tools you will need to use for remote learning. The Remote Learning Guide for students includes guides to completing quizzes or exams in D2L Brightspace, with or without Respondus LockDown Browser and Monitor, using D2L Brightspace, joining online meetings or lectures, and collaborating with the Google Suite.
- Information on Copyright for Faculty and students.

Accessibility

- Similar to an accessibility statement, use this section to describe your commitment to making this course accessible to students with disabilities. Improving the accessibility of your course helps minimize the need for accommodation.
- Outline any technologies used in this course and any known accessibility features or barriers (if applicable).
- Describe how a student should contact you if they discover an accessibility barrier with any course materials or technologies.

Academic Accommodation Support

Academic Accommodation Support (AAS) is the university's disability services office. AAS works directly with incoming and returning students looking for help with their academic accommodations. AAS works with any student who requires academic accommodation regardless of program or course load.

- Learn more about Academic Accommodation Support.

- Learn how to register with AAS.

Academic Accommodations (for students with disabilities) and Academic Consideration (for students faced with extenuating circumstances that can include short-term health issues) are governed by two different university policies. Learn more about Academic Accommodations versus Academic Consideration and how to access each.

Wellbeing Support

At Toronto Metropolitan University, we recognize that things can come up throughout the term that may interfere with a student's ability to succeed in their coursework. These circumstances are outside of one's control and can have a serious impact on physical and mental well-being. Seeking help can be a challenge, especially in those times of crisis.

If you are experiencing a mental health crisis, please call 911 and go to the nearest hospital emergency room. You can also access these outside resources at anytime:

- **Distress Line:**24/7 line for if you are in crisis, feeling suicidal or in need of emotional support (phone: 416-408-4357)
- **Good2Talk:**24/7-hour line for postsecondary students (phone: 1-866-925-5454)
- **Keep.meSAFE:** 24/7 access to confidential support through counsellors via My SSP app or 1-844-451-9700

If non-crisis support is needed, you can access these campus resources:

- **Centre for Student Development and Counselling:** 416-979-5195 or email csdc@torontomu.ca
- **Consent Comes First - Office of Sexual Violence Support and Education:** 416-919-5000 ext 3596 or email osvse@torontomu.ca
- **Medical Centre:** call (416) 979-5070 to book an appointment

We encourage all Toronto Metropolitan University community members to access available resources to ensure support is reachable. You can find more resources available through the Toronto Metropolitan University Mental Health and Wellbeing website.