

Course Outline (F2026)

COE501: Electromagnetism: Theory and Effects

Instructor(s)	Dr. Jonathan Mar [Coordinator] Office: ENG 449 Phone: (416) 979-5000 x 557581 Email: jdmar@torontomu.ca Office Hours: Mondays 11:00 am - 12:00 pm by email
Calendar Description	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, capacitance, magnetic field intensity, Ampere's circuital law and magnetic flux density, Magnetic forces, Faraday's Law, Self and mutual inductance, time-varying fields, Maxwell's equations, electromagnetic effects on circuits, grounding, shielding and electrical termination.
Prerequisites	MTH312
Antirequisites	ELE401
Corerequisites	None
Compulsory Text(s):	1. F.T. Ulaby and U. Ravaioli, Fundamentals of Applied Electromagnetics, 8th edition, Pearson Education, 2020. 2. M.N.O. Sadiku, Elements of Electromagnetics, 7th edition, Oxford University Press, 2018.
Reference Text(s):	1. C. R. Paul, Introduction to Electromagnetic Compatibility, 2nd edition, New York: John Wiley & Sons, 2006. 2. W.H. Hayt and J.A. Buck, Engineering Electromagnetics, 8th edition, McGraw-Hill, 2012. 3. D.K. Cheng, Fundamentals of Engineering Electromagnetics, Addison-Wesley, 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, Faradays law, and Maxwell's equations for time-varying fields. 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. Demonstrate an understanding of how electromagnetic waves propagate on transmission lines, power flow, and impedance concepts relating to transmission lines. Demonstrate an understanding of electromagnetic effects on circuits, sources of electromagnetic interference, and electromagnetic compatibility considerations. (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	3.0 hours of lecture per week for 13 weeks 2.0 hours of tutorial per week for 12 weeks								
Teaching Assistants	Quinn McGovern (qrmcgovern@torontomu.ca) Feze Golshani Gharie Ali (feze.golshani@torontomu.ca) Srikanth Reddy Mandhumula (srikanth.mandhumula@torontomu.ca) Kianoosh Naghib Zadeh (kianoosh.naghibzadeh@torontomu.ca)								
Course Evaluation	<table> <tr> <td>Quizzes</td><td>20 %</td></tr> <tr> <td>Mid-Term Exam</td><td>30 %</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).	Quizzes	20 %	Mid-Term Exam	30 %	Final Exam	50 %	TOTAL:	100 %
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Examinations	All assessments (i.e. quizzes, mid-term exam, and final exam) will be carried out in person. Quizzes: Four (4) quizzes, each worth 5%, will be conducted. 30 minutes duration each. Mid-Term Exam: Conducted in Week 7, covers the material from Weeks 1-6. 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	NOTE: This course has only Theory components. Therefore, to pass the course, a student must simply obtain a minimum overall mark of 50%.								
Teaching Methods	1. Lectures will be delivered synchronously (i.e. for all students at the same time) during the scheduled lecture hours in person. 2. Notes/slides from the lectures will be posted on D2L. 3. Zoom recordings of the lectures will also be posted on D2L.								
Other Information	None								

Course Content

Week	Hours	Chapters / Section	Topic, description
1	3	Ulaby: 1-1 to 1-6, 3-1 to 3-7	1. Introduction to Electromagnetism 2. Review of Vector Analysis and Coordinate Systems
2-7	18	Ulaby: 4-1 to 4-11	3. 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
8-10	9	Ulaby: 5-1 to 5-8	4. Magnetostatics: Magnetic forces and torques Biot-Savart law Gauss's law for magnetism Ampere's law Vector magnetic potential Magnetic properties of materials Magnetic boundary conditions Inductance Magnetic energy
11	3	Ulaby: 6-1 to 6-7	5. Maxwell's equations for time-varying fields: Faraday's law Stationary loop in a time-varying magnetic field Ideal transformer Moving conductor in a static magnetic field The electromagnetic generator Moving conductor in a time-varying magnetic field Displacement current Maxwell's equations in point form Radiation from dipoles and monopoles
12	3	Ulaby: 2-1 to 2-9	6. Transmission lines Transmission-line equations Wave propagation on a transmission line Lossless microstrip line Lossless transmission line

			Wave impedance Power flow
13	3	D2L	7. Electromagnetic effects on circuits: Introduction to EMC (Paul, Sections 1-1 to 1-3) EMC requirements for electronic systems (Paul, Chapter 2) Electromagnetic shielding (Paul, Section 11.1) Grounding (Paul, Section 11.2) Electromagnetic Interference and Compatibility (Sadiku, Section 13.10)

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 further information on common questions.

Important Resources Available at Toronto Metropolitan University

- [The University Libraries](#) provide research [workshops](#) and individual consultation appointments. There is a drop-in Research Help desk on the second floor of the library, and students can use the [Library's virtual research help service](#) to speak with a librarian, or [book an appointment](#) to meet in person or online.
- [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, always require documentation. Students must notify their faculty/contract lecturer once a request for academic consideration is submitted. See Senate [Policy 167: Academic Consideration](#).

Longer absences are not addressed through Policy 167 and should be discussed with your Chair/Director/Program to be advised on next steps.

- [FAQs Academic Considerations and Appeals](#)
- Information on Copyright for [Faculty/Contract Lecturers](#) and [students](#).
- Information on Academic Integrity for [Faculty/Contract Lecturers](#) and [students](#).

Academic Program Advising Contacts

Visit the Electrical, Computer and, Biomedical Engineering department's [faculty page](#) for contact information.

Lab Safety

Students are to strictly adhere and follow:

- a. The Lab Safety information/guidelines posted in the respective labs,
- b. provided in their respective lab handouts, and
- c. instructions provided by the Teaching Assistants/Course instructors/Technical Staff.

During the lab sessions, to avoid tripping hazards, the area around the lab stations should not be surrounded by bags, backpacks etc, students should place their bags, backpacks etc against the walls of the labs and/or away from their lab stations in such a way that it avoids tripping hazards.

Accessibility

Please see the Toronto Metropolitan University's Accessibility [website](#) for the university's statement on accessibility.

Academic Accommodation Support

[Academic Accommodation Support](#) (AAS) is the university's accessibility services office, supporting students with disabilities. AAS works with students, faculty, and staff to create inclusive learning environments, reduce barriers, and promote accessibility across the university.

If you have (or suspect you may have) a disability, AAS can provide consultation, guide you through registration, develop accommodation plans where appropriate, and connect you with supports and services. For information about eligibility, documentation requirements, registration, deadlines, and available services, visit AAS.

Academic Accommodations (for students with disabilities) and Academic Consideration (for short-term extenuating circumstances) are governed by *different university policies*. Learn more about each process and how to access support. Students registered with AAS may request academic consideration (related or unrelated to their disability) if they experience extenuating circumstances that impact their ability to meet their shorter term academic obligations. This includes short term physical or mental health issues that are sudden/acute (e.g, the flu), unexpected illness or injury, hospitalization or treatment, and significant aggravation of a pre-existing condition. Please see [Policy 167: Academic Consideration](#) for more information and details.

Please note that there is no accommodation for missing/rescheduling or reweighting of tests - this is considered an alternate arrangement. Any student who misses a test/exam will be directed to submit an ACR to explore if possible alternate arrangements under [Policy 167: Academic Consideration](#) can apply .

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 Wellbeing Central](#) website.