

**Western University**  
**Faculty of Engineering**  
**Department of Electrical and Computer Engineering**

**ECE 3336B: ELECTROMAGNETIC THEORY**

**Course Outline 2023-24**

**Description:** This course is concerned with the study of electromagnetic phenomena arising in engineering applications. The phenomena are explored via a mathematical treatment of the laws governing electromagnetic fields. The main objective of this course is to learn how to apply these laws to the many and widely ranging applications, which arise in electrical engineering and gain a fundamental understanding of the phenomena occurring therein. Electromagnetic theory is the foundation of electrical engineering and, as such, a basic understanding of electromagnetic phenomena is essential for an in-depth understanding of many other modern applications such as communication systems, high-speed digital systems, and power systems.

**Instructor:** Prof. Jayshri Sabarinathan  
ACEB 3468, [jsabarin@uwo.ca](mailto:jsabarin@uwo.ca)  
Consultation Hours: By appointment

**Academic Calendar Copy:** A vector treatment of the theory of electric and magnetic fields. Integral and differential forms of Maxwell's equations. Boundary conditions. Scalar and vector potentials, reflection and transmission of electromagnetic waves in dielectric and conducting media.

**Contact Hours:** 3 lecture hours/week, 1 tutorial hour/week, 0.5 course.

**Antirequisite:** Physics 3300a/b

**Prerequisites:** NMM 2276A/B or the former Applied Mathematics 2276A/B, NMM 3415A/B or the former Applied Mathematics 3415A/B, ECE 2233A/B, ECE 2236A/B.

Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you will be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from the course for failing to have the necessary prerequisites.

**CEAB Units:** Science 65%, Engineering Science 35%

**Course Textbook:**

U.S. Inan, A.S. Inan, R.K. Said, Engineering Electromagnetics and Waves, Pearson, 2016. Available at Taylor Library: [QC670.I5 2016](#) and Bookstore  
(1<sup>st</sup> edition, 1999: [QC670 .I52 1999](#) is available on reserves – any edition is good)  
F.T. Ulaby and U. Ravaioli, Fundamentals of Applied Electromagnetics, 8th edition, Pearson, 2019. <http://em8e.eecs.umich.edu/> (ONLINE content)

**Recommended Reference Books:**

M.N.O. Sadiku, Elements of Electromagnetics, Oxford University Press, 2010.  
 Available at Taylor Library – On reserve: [QC760.S23x 2010](#).

N.N. Rao, Elements of Engineering Electromagnetics, Prentice Hall, New Jersey 1987.  
 Available at Taylor Library – On reserve: [QC670.N3 1987](#).

S. Ramo, J. Whinnery and T. van Duzer, Fields and Waves in Communications Electronics, Wiley, 1994, Available at Taylor Library [OC670.R3 1994](#)

C.R. Wylie, Advanced Engineering Mathematics, McGraw-Hill, New York, 1995.  
 Available at Taylor Library: [QA401.W9 1995](#).

**General Learning Objectives (CEAB Graduate Attributes)**

Knowledge Base	A	Use of Engineering Tools	Impact on Society and the Environment
Problem Analysis	A	Individual and Team Work	Ethics and Equity
Investigation		Communication Skills	Economics and Project Management
Design		Professionalism	Life-Long Learning

[Notation: *I*: Introductory, *D*: Intermediate, *A*: Advanced, or empty. **I** – The instructor will introduce the topic at the level required. It is not necessary for the student to have seen the material before. **D** – There may be a reminder or review, but the student is expected to have seen and been tested on the material before taking the course. **A** – It is expected that the student can apply the knowledge without prompting (e.g. no review).]

Course Topics and Specific Learning Outcomes	CEAB Graduate Attributes Indicators
<p><b>1. Static Electric in different dielectric and conducting media</b></p> <p>At the end of this section, students will be able to:</p> <ul style="list-style-type: none"> <li>a. understand integral and differential forms of electrostatic laws</li> <li>b. analyse basic static electric structures and interfaces between different media and apply boundary conditions and using Laplace equations</li> <li>c. describe and analyse electric circuits from field prospective</li> </ul>	KB3, KB4, PA1, PA2, PA3
<p><b>2. Magnetic Fields in different media</b></p> <p>At the end of this section, students will be able to:</p> <ul style="list-style-type: none"> <li>a. understand integral and differential forms of magnetic field laws and apply boundary conditions</li> <li>b. analyse basic magnetic structures and interfaces between</li> </ul>	KB3, KB4, PA1, PA2, PA3

different media	
<p><b>3. Time-varying Electromagnetic Fields &amp; Maxwell's Equations</b></p> <p>At the end of this section, students will be able to:</p> <ol style="list-style-type: none"> <li>apply Maxwell's equations for harmonic fields in phasor and time-domain</li> <li>formulate and mathematically describe basic and general EM problems in terms of EM fields and potential, boundary conditions and provide analytical solutions for basic structures.</li> <li>analyse basic electromagnetic structures for time-varying electromagnetic fields and their applications using Maxwell's equations.</li> </ol>	KB3, KB4, PA1, PA2, PA3
<p><b>4. Electromagnetic Wave Equations and Electromagnetic Waves</b></p> <p>At the end of this section, students will be able to:</p> <ol style="list-style-type: none"> <li>understand uniform plane wave propagation in lossless and lossy media.</li> <li>apply EM field concepts for description of non-ideal electric circuits.</li> </ol>	KB3, KB4, PA1, PA2, PA3

## Evaluation

Course Component	Weight
Assignments (Not graded)	0%
Quizzes	25%
Midterm Exam	30%
Final Examination	45%

To obtain a passing grade in the course, a mark of 50% or more must be achieved on the final examination. A final examination mark < 50% will result in a final course grade of 48% or less.

**Assignments:** Assignments will be given approximately every second week. The assignments will be posted on the course website and are not graded and allow students to practice working out solutions.

**Quizzes:** Quizzes will be given approximately every month during the tutorial hour. The quiz schedule will be posted and updated on the course website. Missed quizzes will not be rescheduled.

**Midterm Examination:** The midterm examination will be a closed book examination held during course lecture hours (date TBD). The midterm examination will be 1 hour and 50 minutes in duration. Allowed materials will include 1 sheet of paper (US letter, one side only) handwritten only with equations, and a NONPROGRAMMABLE calculator. No text books, course notes, solutions, other notes or internet connected devices will be allowed.

**Final Examination:** The final examination will take place during the regular examination period. The final examination will be a closed book examination and 3 hours in duration. Allowed materials include 1 sheet of paper (US letter, both sides ok) or 2 sheets of paper (US letter, one-side only) handwritten only with equations, and a NON-PROGRAMMABLE calculator. No text books, course notes, solutions, other notes or internet connected devices will be allowed.

**Use of English:** In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for improper use of English. Additionally, poorly written work with the exception of the final examination may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

**Attendance:** Any student who, in the opinion of the instructor, is absent too frequently from class, laboratory, or tutorial periods will be reported to the Dean (after due warning has been given). On the recommendation of the department, and with the permission of the Dean, the student will be debarred from taking the regular final examination in the course.

**Absence Due to Illness or Other Circumstances:** Students should immediately consult with the instructor or department Chair if they have any problems that could affect their performance in the course. Where appropriate, the problems should be documented as per the “Instructions for Students Unable to Write Tests or Examinations or Submit Assignments as Scheduled” policy. The student should seek advice from the instructor or department Chair regarding how best to deal with the problem. Failure to notify the instructor or department Chair immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

For more information concerning medical accommodations, see the relevant section of the Academic Handbook:

[http://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/accommodation\\_medical.pdf](http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_medical.pdf)

For more information concerning accommodations for religious holidays, see the relevant section of the Academic Handbook:

[http://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/accommodation\\_religious.pdf](http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_religious.pdf)

**Missed Midterm Examinations and quizzes:** If a student misses a midterm examination or quiz, the test will not be rescheduled. The student must follow the Instructions for Students Unable to Write Tests and provide documentation to their department within 24 hours of the missed test. The department will decide whether to allow the reweighting of the test, where reweighting means the marks normally allotted for the midterm will be added to the final

exam or in case of the quiz (to another quiz or to the midterm exam as applicable). If no reasonable justification for missing the test can be found, then the student will receive a mark of zero for the test.

If a student is going to miss the midterm examination or quiz for religious reasons, they must inform the instructor in writing within 48 hours of the announcement of the exam date or they will be required to write the exam.

For any individual deliverables worth less than 10% of the overall course grade, students should still follow the same procedure through the faculty to request accommodation. If justified, then the weighting of that deliverable will be added to another component of the course as appropriate.

**Cheating and Plagiarism:** Students must write their essays and assignments in their own words. Whenever students take an idea or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. University policy states that cheating, including plagiarism, is a scholastic offence. The commission of a scholastic offence is attended by academic penalties, which might include expulsion from the program. If you are caught cheating, there will be no second warning.

All required papers may be subject to submission for textual similarity review to commercial plagiarism-detection software under license to the University for the detection of plagiarism. All papers submitted will be included as source documents on the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between the University of Western Ontario and Turnitin.com (<http://www.turnitin.com>).

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, in the relevant section of the Academic Handbook:

[http://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/scholastic\\_discipline\\_undergrad.pdf](http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf)

**Use of Electronic Devices:** Students may use laptops, tablet computers, or smart phones *only* to access the course OWL site during lectures and tutorials. Use of *nonprogrammable* calculators *only* is permitted during quizzes and examinations. No other electronic devices may be used at any time during lectures, tutorials, or examinations.

**Intellectual Property Statement:** Course material (i.e. course content, videos, solutions, assignment/tutorial questions and other supplementary material posted on OWL) is the intellectual property of your instructors and course developers and is made available to you for your personal use in this course. Sharing, posting, selling or using this material outside your personal use in this course is considered to be an infringement of intellectual property rights.

**Policy on Repeating All Components of a Course:** Students who are required to repeat an Engineering course must repeat all components of the course. No special permissions will be granted enabling a student to retain laboratory, assignment, or test marks from previous years. Previously completed assignments and laboratories cannot be resubmitted by the student for grading in subsequent years.

**Internet and Electronic Mail:** Students are responsible for regularly checking their Western e-mail and the course web site (<https://owl.uwo.ca/portal/>) and making themselves aware of any information that is posted about the course.

**Accessibility:** Please contact the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 519-661-2111 ext. 82147 for any specific question regarding an accommodation.

**Support Services:**

Office of the Registrar, <http://www.registrar.uwo.ca/>

Student Development Centre, <http://www.sdc.uwo.ca/>

Engineering Undergraduate Services, <http://www.eng.uwo.ca/undergraduate/>

USC Student Support Services, <http://westernusc.ca/services/>

Students who are in emotional/mental distress should refer to Mental Health @ Western, [http://www.health.uwo.ca/mental\\_health/](http://www.health.uwo.ca/mental_health/), for a complete list of options about how to obtain help.