University of Manitoba | Price Faculty of Engineering
Department of Electrical and Computer Engineering

Course Outline

Instructor

- Prof. Behzad Kordi, P.Eng.
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Office Hours

- Tuesday, 11:30AM–12:00PM,
  Wednesday, 2:30PM–3:00PM,
  Thursday, 11:30AM–12:00PM,
  or by appointment

Teaching Assistants

- Amirmasoud Amirkabiri
  amirkaba@myumanitoba.ca
- Manuja Gunawardana
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- Hamed Moraditavasani
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Contact Hours

- 4 credit hours
- Lectures:
  3 hours x 13 weeks = 39 hours
- Laboratories:
  3 hours x 5 weeks = 15 hours
- Tutorials (compulsory):
  1 hour x 12 weeks = 12 hours

Prerequisites:

- ECE 2240 Numerical Methods for Electrical Engineers
- PHYS 2152 Modern Physics for Engineers
- MATH 3132 Engineering Mathematical Analysis

Course Website:

https://umanitoba.ca/umlearn

Traditional Territories Acknowledgement

The University of Manitoba campuses and the Department of Electrical and Computer Engineering are located on the original lands of the Anishinaabeg, Cree, Oji-Cree, Dakota, and Dene peoples, and on the homeland of the Métis Nation.

We respect the Treaties that were made on these territories, we acknowledge the harms and mistakes of the past, and we

ECE 3580 – Foundations of Electromagnetics

Fall 2021

IMPORTANT NOTICE – Mandatory Requirement to Report

This course will be conducted using remote instruction. Students who are accessing the course from outside of Canada or the USA ***must notify the instructor*** and indicate in which country they are located. Access to software may be restricted from some countries and failure to comply with these restrictions may result in criminal prosecution.

Course Objectives

The foundations of electromagnetic field theory using vector-calculus and other mathematical and numerical computation techniques applicable to engineering problems will be covered. The electrostatic and magnetostatic cases are covered first before the general time-varying case is studied based on Maxwell's equations. Time-invariant problems are studied using the electric-scalar and magnetic-vector potentials and boundary value electrostatic problems are solved for some practical situations. Transient and time-harmonic electromagnetic field problems are discussed and the concept of electromagnetic plane waves is introduced. Laboratories are used to reinforce the course material using computer programming exercises in MATLAB to implement computational techniques.

Course Content

The following topics will be covered:

- Electrostatics
  - Coulomb's law, electric force, the electric field
  - Gauss's law, electric potential, conductors in a static electric field
  - Solving boundary value problems, boundary conditions
  - Dielectrics in a static electric field, electric flux density, polarization vector, capacitance
  - Electrostatic energy and forces
- Magnetostatics
  - Biot-Savart law, magnetic force, the magnetic field
  - Ampère's circuital law, vector magnetic potential
  - Magnetization, magnetic field intensity, relative permeability, magnetic circuits
  - Boundary conditions, self and mutual inductance
  - Energy in magnetostatic systems, forces and torques
- Electromagnetic Fields
  - Electromagnetic induction, displacement current density
  - Maxwell's equations in differential and integral form
  - Electromagnetic boundary conditions, wave equations
  - Time-harmonic electromagnetic fields and plane waves
  - Flow of electromagnetic power and the Poynting vector

Textbook (Optional)

Fundamentals of Applied Electromagnetics, F.T. Ulaby and U. Ravaioli, 7th edition, Pearson, 2015, ISBN: 0-133-35681-7.

Other References

Field and Wave Electromagnetics, D.K. Cheng, 2nd edition, Addison-Wesley, 1989, ISBN: 0-201-12819-5.

Important Dates

- **Term Test**
  October 14th, 2021
  6:00PM – 9:00PM
  November 15th, 2021
  6:00PM – 9:00PM
- **Voluntary Withdrawal Deadline**
  November 23rd, 2021
- **National Day for Truth and Reconciliation**
  September 30th, 2021
  No classes or examinations
- **Thanksgiving Day**
  October 11th, 2021
  No classes or examinations
- **Remembrance Day**
  November 11th, 2021
  No classes or examinations
- **Fall Term Break**
  November 8th –12th, 2021
  No classes or examinations

Accreditation Details

Accreditation Units

- Mathematics: 0%
- Natural Science: 50%
- Complementary Studies: 0%
- Engineering Science: 50%
- Engineering Design: 0%

Graduate Attributes

KB: A knowledge base for engineering
PA: Problem analysis
IN: Investigation
DE: Design
ET: Use of engineering tools
IT: Individual and team work
CS: Communication skills
PR: Professionalism
IE: Impact of engineering on society/ environment
EE: Ethics and equity
EP: Economics and project management
LL: Life-long learning

Competency Levels

1 - Knowledge (Able to recall information)
2 - Comprehension (Ability to rephrase information)
3 - Application (Ability to apply knowledge in a new situation)
4 - Analysis (Able to break problem into its components and establish relationships.)
5 - Synthesis (Able to combine separate elements into a whole)
6 - Evaluation (Able to judge the worth of something)

Learning Outcomes

1. Acquire an understanding of Electrostatics Laws with ability to apply them to determine electric fields, electric potentials, capacitance, energy and forces in various electrostatic systems.
2. Acquire an understanding of Magnetostatics Laws with ability to apply them to determine magnetic fields, magnetic vector potentials, self and mutual inductance, energy and forces in various magnetostatic systems.
3. Acquire an understanding of classical Electromagnetic Field Theory via Maxwell's Equations with the ability to determine induced voltage using Faraday's law of electromagnetic induction, and to calculate time-varying electric field due to a time-varying magnetic field (and, vice versa) in free space.
4. Acquire the ability to derive source-free wave equations and analyze plane waves in the time and frequency domains from field theory in free space.

Expected Competency Levels

Outcome	KB	PA	IN	DE	ET	IT	CS	PR	IE	EE	EP	LL
1	3	4			3		2					1
2	3	4			3		2					1
3	3	4		2	3		2					1
4	3	4										1

Evaluation

Students must receive a minimum of 50% on the final examination in order to be eligible to receive a passing grade. Students who are unable to write the mid-term exam for medical (or other acceptable) reasons will have their final examination weighted to include the mid-term weighting. Students must complete all the laboratories in order to be eligible to receive a passing grade.

Component	Value (%)	Method of Feedback	Learning Outcomes Evaluated
Laboratories	15	F, S	1, 2, 3
Quizzes (best 3 of 4)	10	F, S	1, 2, 3, 4
Term Tests ❖	35	F, S	1, 2
Final Examination	40	S	1, 2, 3, 4

∗ Method of Feedback: **F** - Formative (written comments and/or oral discussion), **S** - summative (numerical grade)

❖ The better of two tests will be weighted at 20%, while the other will be weighted at 15%.

CEAB Graduate Attributes Assessed

KB.3 – Recalls and defines, and/or comprehends and applies information, first principles, and concept in fundamental engineering science.

PA.2 – Develops and/or implements a strategy to analyze complex engineering problems.

Retention of Student Work

Students are advised that copies of their work submitted in completing course requirements (i.e. assignments, laboratory reports, project reports, test papers, examination papers, etc.) may be retained by the instructor and/or the department for the purpose of student assessment and grading, and to support the ongoing accreditation of each Engineering program. This material shall be handled in accordance with the University's Intellectual Property Policy and the protection of privacy provisions of The Freedom of Information and Protection of Privacy Act (Manitoba). Students who do not wish to have their work retained must inform the Head of Department, in writing, at their earliest opportunity.

Grading Scale

Letter	Mark
A+	95–100
A	85–94
B+	80–84
B	70–79
C+	65–69
C	55–64
D	45–54
F	< 45

Note: These boundaries represent a guide for the instructor and class alike. Provided that no individual student is disadvantaged, the instructor may vary any of these boundaries to ensure consistency of grading from year-to-year.

Academic Integrity

Students are expected to conduct themselves in accordance with the highest ethical standards of the Profession of Engineering and evince academic integrity in all their pursuits and activities at the university. As such, in accordance with the *General Academic Regulations* on *Academic Integrity*, students are reminded that plagiarism or any other form of cheating in examinations, term tests, assignments, projects, or laboratory reports is subject to serious academic penalty (e.g. suspension or expulsion from the faculty or university). A student found guilty of contributing to cheating by another student is also subject to serious academic penalty.

Requirements and Regulations

- Attendance at lectures and laboratories is essential for successful completion of this course. Students must satisfy each evaluation component in the course to receive a final grade.
- It is the responsibility of each student to contact the instructor in a timely manner if he or she is uncertain about his or her standing in the course and about his or her potential for receiving a failing grade. Students should also familiarize themselves with the University's *General Academic Regulations*, as well as Section 3 of the Faculty of Engineering *Academic Regulations* dealing with incomplete term work, deferred examinations, attendance and withdrawal.
- No programmable devices or systems (such as calculators, PDAs, iPods, iPads, cell phones, wireless communication or data storage devices) are allowed in examinations unless approved by the course instructor.
- Students should be aware that they have access to an extensive range of resources and support organizations. These include Academic Resources, Counselling, Advocacy and Accessibility Offices as well as documentation of key University policies e.g. Academic Integrity, Respectful Behaviour, Examinations and related matters.

Supplemental Resources

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