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

## Course Outline

### Instructor

- Prof. Greg Bridges, P.Eng.
  E3–465 EITC
  (204) 474–8512
  Gregory.Bridges@umanitoba.ca
  (Reference to ECE 3590 must appear in the subject line.)


### Office Hours
- Tuesdays, 11:30AM – 12:30PM
  or by appointment

### Teaching Assistant
- Amiramasoud Amirkabiri
  Amirmasoud.Amirkabiri@umanitoba.ca
- Marjan Kashani
  Kashani.Marjan@umanitoba.ca

### Contact Hours
- 4 credit hours
- Lectures:
  3 hours x 13 weeks = 39 hours
- Laboratories:
  3 hours x 5 weeks = 15 hours

### Prerequisites:
- ECE 3580 Foundations of Electromagnetics

### Course Website:
http://umanitoba.ca/umlearn

## Important Dates

- **Term Test**
  Thursday, March 11th, 2021
  6:00PM – 8:00PM
- **Voluntary Withdrawal Deadline**
  March 31st, 2021
- **Louis Riel Day**
  February 15th, 2021
  No classes or examinations
- **Spring Break**
  February 16th – 19th, 2021
  No classes or examinations
- **Good Friday**
  April 2nd, 2021
  No classes or examinations

# ECE 3590 – Electromagnetic Theory

Winter 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

Obtain an understanding of Maxwell's equations and be able to apply them to solving practical electromagnetic field problems. Fundamental concepts covered will include: laws governing electrodynamics, plane wave propagation in different media, power flow, polarization, transmission and reflection at an interface, transmission lines, microwave networks, waveguides, radiation and antennas. Experiment and computer simulation based laboratories are used to reinforce the course material.

## Course Content

The following topics will be covered:

- Maxwell's Equations: Review of current continuity, Faraday's law, Ampère-Maxwell's law, time-harmonic fields, scalar and vector potentials, boundary conditions
- Plane Electromagnetic Waves: Uniform plane waves, phase and group velocity, wave impedance, dielectric and conducting media, polarization, energy and Poynting vector
- Plane Wave Reflection and Refraction: Normal and oblique incidence at media boundaries
- Transmission Line Theory: Distributed parameter model, transmission line equations, lossless and lossy lines, terminated t-lines, Smith chart, impedance matching, waveguides (if time permits)
- Microwave Networks: S-parameters, basic microwave circuits
- Radiation and Antennas: Radiation from a dipole, arrays, antenna parameters, introduction to communication systems.

## Textbook

*Fundamentals of Applied Electromagnetics*, 7th edition, F.T. Ulaby and U. Ravaioli, Pearson, 2015. (http://www.amazon.ca) (www.em7e.eecs.umich.edu)

## Other Resources

*Conceptual Electromagnetics*, B. M. Notaroš, CRC Press, 2017.

*Field and Wave Electromagnetics*, D.K. Cheng, Pearson, 2nd edition, 1989.

## Learning Outcomes

1. Acquire an understanding of Maxwell's equations and be able to manipulate and apply them to EM problems.
2. Formulate and analyse problems involving uniform plane waves in lossy media with planar boundaries.
3. Able to derive, analyse, and apply the steady state transmission line equations to the design of simple distributed circuit components.
4. Derive the radiated field from an elementary current source.
5. For simple antennas derive fundamental antenna parameters starting from Maxwell's equations and be able to use these in the design of rudimentary communications systems.

## Accreditation Details

### Accreditation Units

- Mathematics: 0%
- Natural Science: 25%
- Complementary Studies: 0%
- Engineering Science: 75%
- Engineering Design: 0%

### 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 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)

### 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.

## Expected Competency Levels

| Outcome | KB | PA | IN | DE | ET | IT | CS | PR | IE | EE | EP | LL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 3 | 3 | 2 | | | | | | | | 1 |
| 2 | 3 | 3 | 3 | 3 | 3 | | | | | | | 1 |
| 3 | 4 | 4 | 4 | 4 | 5 | | | | | | | 1 |
| 4 | 2 | 3 | 2 | 2 | | | | | | | | 1 |
| 5 | 3 | 3 | 2 | 5 | | | | | 1 | | | 1 |

## CEAB Graduate Attributes Assessed

KB.4 – Recalls and defines, and/or comprehends and applies, first principles and concepts in specialized engineering science.
IN.2 – Devises and/or implements an appropriate plan/methodology for gathering information required to solve a complex engineering problem.

## Evaluation

The student's grade will be determined from their performance in quizzes, assigned exercises, one mid-term test and the final exam. 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 components of the course and receive a minimum grade of 50% on the final examination to be eligible for a passing grade in the course.

| Component | Value (%) | Method of Feedback | Learning Outcomes Evaluated |
|---|---|---|---|
| Quizzes | 15 | S | 1, 2, 3, 4, 5 |
| Laboratories | 15 | F, S | 1, 2, 3, 4, 5 |
| Term Test | 25 | S | 1, 2, 3 |
| Final Examination | 45 | S | 1, 2, 3, 4, 5 |

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

## 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.

## Copyright Notice



## 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.

## Requirements/Regulations

- Attendance at lectures and laboratories is essential for successful completion of this course. Students must pass each evaluation component in the course to receive a passing 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, smart watches, 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 Information*