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

Course Outline

ECE 4270 – Antennas

Fall 2021

IMPORTANT NOTICE – In-Person Laboratories

This course will be delivered using online lectures, and a combination of remote and *in-person laboratories*. ***Students are required to pre-screen themselves*** before travelling to campus for their laboratory and must not attend the campus if they are experiencing any COVID-19 symptoms or if they have been in contact with someone who has tested positive for COVID-19.

In addition, the University requires that ***all students must be fully vaccinated*** (first dose by Sept 22nd, second dose by October 31st). As well, ***students must wear a face mask*** at all times while attending the laboratory and in all common indoor spaces on campus, or whenever social distancing can not be maintained. For further information, please visit the *UofM COVID-19 Resources* website (https://umanitoba.ca/coronavirus/recovery).

Instructor

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Office Hours

- Video call by appointment.

Teaching Assistant

- Mario Phaneuf
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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

Prerequisites:

- ECE 3590 Electromagnetic Theory

Course Website:

https://umanitoba.ca/umlearn

Course Objectives

Fundamental parameters of antennas, including radiation patterns, radiation intensity, beamwidth, directivity, gain, bandwidth, polarization, radiation efficiency, and input impedance will be first covered. Radiation integrals and magnetic and electric vector potential functions will then be presented for the mathematical analysis of radiation problems in near-field and far-field zones. Various types of antennas, including dipoles, monopoles, loops, arrays, open-ended waveguide antennas, horns, microstrips, and reflectors will be presented and studied.

Course Content

The following topics will be covered:

- Review of Maxwell's equations, boundary conditions, time-harmonic fields
- Radiation mechanism, fundamental parameters of antennas, Friis transmission equation, and radar range equation
- Radiation integrals and vector potential functions
- Linear wire antennas (dipoles and monopoles)
- Loop antennas
- Antenna arrays
- Aperture antenna theory
- Open-ended waveguide and horn antennas
- Microstrip antennas
- Reflector antennas
- Antenna measurements

Textbook

Antenna Theory: Analysis and Design, C. A. Balanis, 4th edition, Wiley, 2016.

Learning Outcomes

1. Acquire an understanding of fundamental parameters of antennas with ability to apply them in Friis transmission and radar range equations, and use them as design parameters.
2. Acquire an understanding of radiation integrals and vector potential functions with ability to apply them to calculate electromagnetic fields of antennas from their electric and/or magnetic currents.
3. Acquire an understanding of dipole, monopole, and loop antennas with ability to analyze their radiation patterns and understand some fundamental design considerations.
4. Acquire an understanding of linear antenna arrays with ability to analyze and design ordinary end-fire, broadside, and phased (scanning) arrays.
5. Acquire an understanding of aperture antennas, including open-ended waveguides, horns, microstrips, and reflectors, with ability to perform analysis, and design some aperture antenna elements.

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 dedicate ourselves to move forward in partnership with Indigenous communities in a spirit of reconciliation and collaboration.

Important Dates

- **Term Test**
  November 5th, 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: 0%
- Complementary Studies: 0%
- Engineering Science: 60%
- Engineering Design: 40%

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)

Expected Competency Levels

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

Evaluation

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	20	F, S	1, 2, 3, 4, 5
Project	10	F, S	5
Term Test	30	S	1, 2, 3, 4
Final Examination	40	S	1, 2, 3, 4, 5

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

CEAB Graduate Attributes Assessed

PA.3 – Analyzes and solves complex engineering problems.

DE.1 – Understands the complexities of an open-ended engineering design problem and defines appropriate objectives and constraints.

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

- 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.
- 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

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.

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.