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 cannot be maintained. For further information, please visit the UofM COVID-19 Resources website (https://umanitoba.ca/coronavirus/recovery).

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


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

The University of Manitoba camps 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.
Expected Competency Levels

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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.

**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.
Copyright Notice

All materials provided in this course are copyright and are provided under the fair dealing provision of the Canadian Copyright Act. This material may not be redistributed in any manner without the express written permission of the relevant copyright holder.

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

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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.