ENGINEERING 7811: Antennas

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CALENDAR ENTRY:

ENGI 7811 Antennas examines the fundamentals of electromagnetic radiation; potentials; small antennas and antenna parameters; thin linear wire antennas and antenna arrays; antenna impedance and ground effects; Friis transmission formula; and aperture antennas.

LH: at least three 3-hour simulation and demonstration sessions per semester

PR: ENGI 6813

Credit Value: 3 Credits

Accreditation Units: 40.5 Combined Educational Hours; Focus: 75% Engineering Science, 25% Engineering Design

COURSE DESCRIPTION:

This course extends and applies the concepts encountered in Engineering 6813 (Electromagnetic Fields). In ENGI6813, it was seen that Maxwell's Equations, along with a pair of constitutive relations, Ohm's law, the definition of convection current and the Lorentz force equation, were the means of describing any classical electrodynamical phenomenon. Also intimated, but not discussed, was the fact that current-carrying structures could be responsible for radiated electromagnetic energy. The whole of this course addresses this phenomenon. The *antenna*, as we shall see, is the means of radiating or receiving "radio" waves. As time permits, a further discussion of electromagnetic wave propagation will be included.

SCHEDULE:

Class: Mon., Wed., Fri. at 10 AM	Room #: EN-4035
Tutorials: Thur. at 12 PM	Room #: EN-1002
Labs:	Room #: EN-4035

RESOURCES:

Textbook: None

References: The following are suggested reference materials to which we shall refer from time to time.

(1) Constantine A. Balanis, Antenna Theory – Analysis and Design, Wiley,1997.
(2) Hayt and Buck, Engineering Electromagnetics, 7th ed., McGraw-Hill, 2006.
(3) J.D. Kraus, Antennas, McGraw-Hill, 1988.
(4) W.L. Stutzman and G.A. Thiele, Antenna Theory and Design, 2nd ed., Wiley, 1998.

Notes: Class notes are available for download from **http://www.engr.mun.ca/~egill/** and this site should be checked for course materials on a daily basis.

MAJOR TOPICS:

Unit 1 Electromagnetics Review (Mostly)
1.1 Introduction
1.2 Maxwell's Equations and Related Formulae
1.3 Scalar and Vector Potentials

Unit 2 Small Antennas and Some Antenna Parameters
2.1 The Fundamental Source of Radiated Energy
- 2.2 The Infinitesimal Dipole
- 2.2.1 Reality and Useful "Fiction"
- 2.2.2 The Vector Potential for a Uniform-Current Element
- 2.2.3 The Electric and Magnetic Far-Fields for the Infinitesimal Dipole
- 2.2.4 Radiation Power Density and Radiated Power

2.3 General Antenna Parameters and Characteristics
- 2.3.1 Radiation Pattern and Related Concepts
- 2.3.2 Radiation Power Density, Radiated Power and Radiation Resistance
- 2.3.3 Radiation Intensity, Directivity, and Gain
- 2.3.4 Half-Power Beamwidth
- 2.3.5 Reciprocity

2.4 The Small Current Loop

Unit 3 Linear Wire Antennas and Antenna Arrays
3.1 Thin Linear Wire Dipole Antennas
- 3.1.1 The Vector Potential and Resulting Fields of the Thin Linear Dipole
- 3.1.2 Power Density and Other Parameters

3.1.3 Special Cases of the Thin Dipole

3.2 Images and Monopoles

3.3 Antenna Arrays

3.3.1 Two-Element (Dipole) Array – Free Space Analysis

3.3.2 The Linear Array

3.3.3 The Planar Array

3.4 Long Wire Antennas

Unit 4 A Few "Practical" Considerations

4.1 Antenna Impedance

4.1.2 Mutual Impedance (Two Elements Only)

4.1.3 Driving Point Impedance of a Side-by-Side Dipole Pair

4.2 Ground Effects

4.3 Effective Aperture and the Friis Transmission Formula

4.3.1 Effective Aperture

4.3.2 The Friis Transmission Formula

Unit 5 Aperture Antennas

5.1 Field Equivalence and Related Concepts

5.1.1 Magnetic Current Density, Electric Vector Potential and Duality

5.1.2 More on Images

5.1.3 Field Equivalence

5.1.4 Application – Rectangular Aperture on an Infinite Ground Plane

Topics on Propagation as Time Permits.

ASSESSMENTS:

Evaluation Instrument	Value	Approximate Due Date
Assignments (5 or 6)	10 %	Jan. 20, Feb. 3, 17, Mar. 4, 18, Apr. 1
Term Tests (2)	40%	Feb. 19, March 23
Final Exam	50%	Week of April 11 -

LEARNING OUTCOMES:

Upon successful completion of this course, the student will be able to:

	LEARNING OUTCOMES	GRADUATE ATTRIBUTES. LEVEL OF COMPETENCE	Methods of Assessment
1	Describe mathematically and with a flowchart, the general procedure for finding the electric and magnetic fields from a current source.	1.3	Assignments, Tests, Final Exam
2	Calculate, using Maxwell's equations, electric and magnetic fields given one or the other and describe all relevant physical characteristics of the fields.	1.3,2.3	Assignments, Tests, Final Exam
3	Calculate and illustrate the near, intermediate and far electromagnetic fields and the far-field radiation parameters for small antennas.	1.3,2.3	Assignments, Tests, Final Exam
4	Calculate and illustrate the fields and associated radiation parameters for linear wire antennas and antenna arrays	1.3, 2.3,5.3	Assignments, Simulation Labs, Tests, Final Exam
5	Design antenna systems to meet elementary but practical communications/remote sensing needs.	1.3, 2.3, 3.3, 4.3, 5.3	Assignments, Simulation Labs, Tests, Final Exam
6	Calculate and illustrate the far fields of simple aperture antennas	1.3,2.3	Assignments, Final Exam
7	Communicate technical information in written form.	7.2	Assignments, Simulation Labs, Tests, Final Exam

See www.mun.ca/engineering/undergrad/graduateattributes.pdf for more information on the 12 Graduate Attributes you are expected to be proficient in upon graduation.

Each Graduate Attribute for each learning outcome is rated at a level of proficiency between 1 and 3 (1=introductory, 2=intermediate, 3=sophisticated).

LAB SAFETY:

Students are expected to demonstrate awareness of, and personal accountability for, safe laboratory conduct. Appropriate personal protective equipment (PPE) must be worn (e.g. steel-toed shoes, safety glasses, etc.) and safe work practices must be followed as indicated for individual laboratories, materials and equipment. Students will immediately report any concerns regarding safety to the teaching assistant, staff technologist, and professor.

ACADEMIC INTEGRITY AND PROFESSIONAL CONDUCT:

Students are expected to conduct themselves in all aspects of the course at the highest level of academic integrity. Any student found to commit academic misconduct will be dealt with according to the Faculty and University practices. More information is available at http://www.mun.ca/engineering/undergrad/academicintegrity.php

Students are encouraged to consult the Faculty of Engineering and Applied Science Student Code of Conduct at http://www.mun.ca/engineering/undergrad/academicintegrity.php and Memorial University's Code of Student Conduct at http://www.mun.ca/student/conduct/.

INCLUSION AND EQUITY:

Students who require accommodations are encouraged to contact the Glenn Roy Blundon Centre, http://www.mun.ca/blundon/about/index.php. The mission of the Blundon Centre is to provide and co-ordinate programs and services that enable students with disabilities to maximize their educational potential and to increase awareness of inclusive values among all members of the university community.

The university experience is enriched by the diversity of viewpoints, values, and backgrounds that each class participant possesses. In order for this course to encourage as much insightful and comprehensive discussion among class participants as possible, there is an expectation that dialogue will be collegial and respectful across disciplinary, cultural, and personal boundaries.

STUDENT ASSISTANCE:

Student Affairs and Services offers help and support in a variety of areas, both academic and personal. More information can be found at www.mun.ca/student.