

ECE 753
Modern Antennas in Wireless Telecommunications

COURSE OUTLINE

Please refer to course website for updated information.

CALENDAR DESCRIPTION

This course provides fundamental knowledge in the theory and practice of antenna design and deployment in modern wireless telecommunication systems. The theory of electromagnetic radiation is introduced and the fundamental antenna parameters are explained. Basic antenna measurement techniques are introduced and practiced in a 6-hour laboratory session. The principles of analysis and design of antenna arrays are discussed. Special attention is paid to antennas used in mobile (cellular, satellite) communications. The fundamental limitations of electrically small antennas as well as the principles of smart antennas are briefly introduced through seminar sessions.

SCHEDULE And MODE OF DELIVERY

The material for this course will be delivered through a mixture of in-person lectures, textbook and research articles readings, design projects, and in-person laboratories. The platform for each component is noted at the end of each line.

Lectures: Fridays 12:30 pm – 3:30 pm Format: In person

Labs: flexible time from Dec. 7 to Dec. 22, 2023. Format: In person

INSTRUCTOR

Dr. Natalia K. Nikolova

Email: talia@mcmaster.ca

Office: ITB-A308

Phone: 905-525-9140 ext. 27141

Office Hours: Thursdays 2:30 pm - 3:30 pm. Format: In person or online by appointment

COURSE WEBSITE/S

<http://www.ece.mcmaster.ca/faculty/nikolova/antennas.htm>

COURSE OBJECTIVES

By the end of this course, students should be able to:

- Understand the meaning of the fundamental antenna performance parameters such as gain, directivity, radiation patterns and their characteristics, input impedance and impedance match, efficiency, polarization, and fidelity.
- Use professional design tools to design basic antenna types (dipoles, loops, printed antennas).
- Predict the performance of the open-space communication channel.
- Measure the impedance match and the radiation patterns of antennas.

ASSUMED KNOWLEDGE

Applied Electromagnetics (ElecEng 2FL3) OR Electromagnetics 1 (ElecEng 2FH4)
AND
Electromagnetics 2 (ElecEng 3FK4)

COURSE MATERIALS

Textbooks:

C. A. Balanis, *Antenna Theory*, 3rd ed., Wiley-Interscience, New York, 2005.

Other:

Lecture Notes (available for download from the course website)

Additional Sources:

Antenna Textbooks

W. L. Stutzman and G. A. Thiele, *Antenna Theory and Design*, 2nd ed., Wiley, 1998.

J. D. Kraus and R. J. Marhefka, *Antennas (for all Applications)*, 3rd ed., McGraw-Hill, 2002.
(previous editions authored by Kraus alone are fine, too).

R. S. Elliot, *Antenna Theory and Design*, A Classical Reissue, IEEE Press, 2003.

Elsherbeni and Inman, *Antenna Design & Visualization Using MATLAB*, Scitech, 2006.

On Propagation

R. E. Collin, *Antennas and Radiowave Propagation*, McGraw-Hill, Inc. 1985.

K. Siwiak, *Radiowave Propagation and Antennas for Personal Communications*, 2nd ed.,
Artech House, Inc., Norwood, MA, 1998.

J. Doble, *Introduction to Radio Propagation for Fixed and Mobile Communications*, Artech
House, Inc., Norwood, MA, 1996.

COURSE OVERVIEW

Week Topic

1	Introduction into antenna theory and practice
2	Radiation integrals and auxiliary potential functions; basic EM theorems in antenna problems
3	Fundamental antenna parameters
4	Antenna measurements
5	Infinitesimal dipole; wire and loop radiating elements
6	Wire antennas – dipoles, monopoles, Yagi-Uda array
7	Impedance matching and baluns
8	Antenna arrays – analysis and design
9	Printed antennas
10	Reflector antennas
11	Horn antennas
12	Seminar - Fundamental limitations of electrically small antennas
13	Preparation for labs

A more detailed time line is available on the course web site.

At certain points in the course it may make good sense to modify the schedule. The instructor may modify elements of the course and will notify students accordingly (in class, on the course website).

LABORATORY OVERVIEW

Week Topic

1	Gain of Pyramidal Horn Antennas
2	Experiments with $\lambda/2$, λ , and $3\lambda/2$ Dipoles
3	Half-wave Folded Dipole Antennas and Impedance Transformation with Baluns
4	Circular Polarization and Helical Antennas

ASSESSMENT

Component	Weight	Due Date
Laboratory	20 %	
Weekly Assignments	40 %	
Project	40 %	
Total	100 %	

Late submissions of assignments or project reports are subject to 25% penalty per day (less than one day is counted as one day).

CONDUCT EXPECTATIONS

As a McMaster graduate student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the [Code of Student Rights & Responsibilities](#) (the “Code”). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online.**

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students’ access to these platforms.

COPYRIGHT AND RECORDING

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors.

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

ACADEMIC ACCOMMODATIONS OF STUDENTS WITH DISABILITIES

Students with disabilities who require academic accommodation must contact [Student Accessibility Services](#) (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University’s [Academic Accommodation of Students with Disabilities](#) policy.

ACADEMIC ACCOMMODATION FOR RELIGIOUS, INDIGENOUS OR SPIRITUAL OBSERVANCES (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the [RISO](#) policy. Students should submit their request to their Faculty Office **normally within 10 working days** of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

EXTREME CIRCUMSTANCES

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.

RESEARCH ETHICS

The two principles underlying integrity in research in a university setting are these: a researcher must be honest in proposing, seeking support for, conducting, and reporting research; a researcher must respect the rights of others in these activities. Any departure from these principles will diminish the integrity of the research enterprise. This policy applies to all those conducting research at or under the aegis of McMaster University. It is incumbent upon all members of the university community to practice and to promote ethical behaviour. To see the Policy on Research Ethics at McMaster University, please go to <http://www.mcmaster.ca/policy/faculty/Conduct/ResearchEthicsPolicy.pdf>.

www.eng.mcmaster.ca/ece

Electrical and Computer Engineering Lab Safety

Information for Laboratory Safety and Important Contacts

This document is for users of ECE instructional laboratories in the Information Technology Building.

This document provides important information for the healthy and safe operation of ECE instructional laboratories. This document is required reading for all laboratory supervisors, instructors, researchers, staff, and students working in or managing instructional laboratories in ECE. It is expected that revisions and updates to this document will be done continually. A McMaster University lab manual is also available to read in every laboratory.

General Health and Safety Principles

Good laboratory practice requires that every laboratory worker and supervisor observe the following:

1. Food and beverages are not permitted in the instructional laboratories.
2. A Laboratory Information Sheet on each lab door identifying potential hazards and emergency contact names should be known.

3. Laboratory equipment should only be used for its designed purpose.
4. Proper and safe use of lab equipment should be known before using it.
5. The course TA leading the lab should be informed of any unsafe condition.
6. The location and correct use of all available safety equipment should be known.
7. Potential hazards and appropriate safety precautions should be determined, and sufficiency of existing safety equipment should be confirmed before beginning new operations.
8. Proper waste disposal procedures should be followed.

Location of Safety Equipment

Fire Extinguisher

On walls in halls outside of labs

First Aid Kit

ITB A111, or dial "88" after 4:30 p.m.

Telephone

On the wall of every lab near the door

Fire Alarm Pulls

Near all building exit doors on all floors

Who to Contact

Emergency Medical / Security: On McMaster University campus, call Security at extension **88** or **905-522-4135** from a cell phone.

Non-Emergency Accident or Incident: Immediately inform the TA on duty or Course Instructor.

University Security (Enquiries / Non-Emergency): Dial 24281 on a McMaster phone or dial 905-525-9140 ext. 24281 from a cell phone.

See TA or Instructor: For problems with heat, ventilation, fire extinguishers, or immediate repairs

Environmental & Occupational Health Support Services (EOHSS): For health and safety questions dial 24352 on a McMaster phone or dial 905-525-9140 ext. 24352 from a cell phone.

ECE Specific Instructional Laboratory Concerns: For non-emergency questions specific to the ECE laboratories, please contact 24103.

In Case of a Fire (Dial 88)

When calling to report a fire, give name, exact location, and building.

1. Immediately vacate the building via the nearest Exit Route. Do not use elevators!
2. Everyone is responsible for knowing the location of the nearest fire extinguisher, the fire alarm, and the nearest fire escape.
3. The safety of all people in the vicinity of a fire is of foremost importance. But do not endanger yourself!
4. In the event of a fire in your work area shout "*Fire!*" and pull the nearest fire alarm.
5. Do not attempt to extinguish a fire unless you are confident it can be done in a

prompt and safe manner utilizing a hand-held fire extinguisher. Use the appropriate fire extinguisher for the specific type of fire. Most labs are equipped with Class A, B, and C extinguishers. Do not attempt to extinguish Class D fires which involve combustible metals such as magnesium, titanium, sodium, potassium, zirconium, lithium, and any other finely divided metals which are oxidizable. Use a fire sand bucket for Class D fires.

6. Do not attempt to fight a major fire on your own.
7. If possible, make sure the room is evacuated; close but do not lock the door and safely exit the building.

Clothing on Fire

Do not use a fire extinguisher on people

1. Douse with water from safety shower immediately or
2. Roll on floor and scream for help or
3. Wrap with fire blanket to smother flame (a coat or other nonflammable fiber may be used if blanket is unavailable). Do not wrap a standing person; rather, lay the victim down to extinguish the fire. The blanket should be removed once the fire is out to disperse the heat.

Equipment Failure or Hazard

Failure of equipment may be indicative of a safety hazard - You must report all incidents.

Should you observe excessive heat, excessive noise, damage, and/or abnormal behaviour of the lab equipment:

1. Immediately discontinue use of the equipment.
2. In Power Lab, press wall-mounted emergency shut-off button.
3. Inform your TA of the problem.
4. Wait for further instructions from your TA.
5. TA must file an incident report.

Protocol for Safe Laboratory Practice

Leave equipment in a safe state for the next person - if you're not sure, ask!

In general, leave equipment in a safe state when you finish with it. When in doubt, consult the course TA.

Defined Roles

TA	The first point of contact for lab supervision	
ECE Lab Supervisor	Steve Spencer- ITB 147	steve@mail.ece.mcmaster.ca
ECE Course Instructor	Please contact your specific course instructor directly	
ECE Administrator	Kerri Hastings- ITB A111	hastings@mcmaster.ca
ECE Chair	Tim Davidson- ITB A111	davidson@mcmaster.ca

