Spring 2020

Introduction to Antennas and Propagation

University of Massachusetts Amherst
ECE 597AP

Instructor	Do-Hoon Kwon
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Class meetings	MoWe 2:30–3:45PM
Room	Hasbrouck Addition 107
Office hour	MoWe 4:00–5:00PM and by appointment

Course Goals

1. Understand and use standard antenna parameters
2. Understand and quantify the role of antennas in communication and radar systems
3. Analyze and design wire, broadband, and low-profile antennas
4. Understand the basic properties of radiowave propagation
5. Improve skills in oral and written technical communication through an antenna design team project

Prerequisites

ECE 333 (Fields and Waves I), ECE 584 (Microwave Engineering I; recommended)

Course Website

Moodle

Textbook

W. L. Stutzman and G. A. Thiele, *Antenna Theory and Design*, 3rd ed., Hoboken, NJ: Wiley, 2013.

References

C. A. Balanis, *Antenna Theory: Analysis and Design*, 4th ed., Hoboken, NJ: Wiley, 2016.
J. L. Volakis, *Antenna Engineering Handbook*, 5th ed., New York: McGraw-Hill, 2019.
R. E. Collin, *Antennas and Radiowave Propagation*, New York: McGraw-Hill, 1985.
C. A. Levis, J. T. Johnson, and F. L. Teixeira, *Radiowave Propagation: Physics and Applications*, Hoboken, NJ: Wiley, 2010.

Course Topics

1. Antenna fundamentals (Chapter 2) [4 lectures]
    - Review of Maxwell's equations, boundary conditions, radiation integral
    - Radiation pattern, far fields, gain, directivity, radiation efficiency, antenna impedance, bandwidth, polarization
2. Antennas in systems (Chapter 4) [2 lectures]
    - Receiving antennas, noise, Friis transmission formula, radar range equation
3. Wire and broadband antennas (Chapters 6, 7) [5 lectures]
    - Dipoles, image theory and monopoles, Yagi-Uda antennas
    - Duality and loop antennas

- Helical antennas, spiral antennas

4. Low-profile and compact antennas (Chapter 11) [3 lectures]
    - Microstrip antennas, inverted-F antennas
5. Direct transmission [2 lectures]
    - Additional losses in Friis formula, atmospheric gas effects, rain attenuation
6. Reflection and refraction [3 lectures]
    - Normal and oblique incidence on a planar interface
    - Flat earth, spherical earth, surface (ground) waves
7. Ionospheric propagation [2 lectures]
    - Permittivity of ionized gas
    - Effect of earth's magnetic field
8. Obstacles [3 lectures]
    - Diffraction, a knife-edge model
    - Empirical path loss models

Course Requirements

Homework (10%)
Midterm exam (30%)
Team project report and presentation (30%)
Final exam (30%)

Homework assignments are due at the beginning of the class period on the due date. Late homework will NOT be accepted.

Antenna Simulation Project

A team (2 members/team) antenna project will have the following components:

1. Selecting a target application
2. Reducing the application requirement to antenna specifications
3. Selecting the antenna type
4. Designing size, shape, material, and feeding details
5. Investigating the impedance and radiation characteristics using simulation
6. Writing a report and making a presentation to class

Computer Simulation Tool

The following simulation tool is available for projects:

- CST Studio Suite 2019 by Computer Simulation Technology AG (http://www.cst.com; available for Windows; available in ECS Labs)

Relation of the Course Goals to Student Outcomes

The five course goals are related in part to seven broad capabilities (ABET Student Outcomes) that we expect for all our BS graduates in the EE and CSE programs. These are related as shown in the table below.

Student Outcomes	Course Goals				
	1	2	3	4	5
1. Able to apply engineering, science, and math to identify, formulate, and solve complex problems	Y	Y	Y	Y	Y

2. Able to apply engineering design to produce solutions that meet specified needs	Y	Y	Y	Y	Y
3. Able to communicate effectively with a range of audiences	N	N	N	N	Y
4. Able to recognize ethical and professional responsibilities, and make informed judgments	N	N	N	N	N
5. Able to function effectively on a team	N	N	N	N	Y
6. Able to develop and conduct experiments, analyze and interpret data, and draw conclusions	N	N	N	N	Y
7. Able to acquire and apply new knowledge as needed, using appropriate learning strategies	N	N	N	N	N

Inclusivity

The diversity of the participants of this course is a valuable source of ideas, problem solving strategies, and engineering creativity. If you feel that your contribution is not being valued or respected for any reason, please speak with me privately. If you wish to communicate with someone else in the College, speak with Assistant Dean Dr. Paula Rees (rees@umass.edu, 413.545.6324, 128b Marcus Hall). You may also submit anonymously through the College of Engineering Climate Concerns and Suggestions on-line form (https://tinyurl.com/UMassEngineerClimate) and/or the Positive and Negative Classroom Experience online form (https://tinyurl.com/UMassEngineerClassroom). We are all members of an academic community with a shared responsibility to cultivate a climate where all students/individuals are valued and where both they and their ideas are treated with respect.