

EE 474 Antennas

Credits: 3

Categorization of credits: engineering topic

Instructors or course coordinator: Magdy F. Iskander

Textbook and Other Required Materials:

Chapter 9 of the text *Electromagnetic Fields and Waves* by M. F. Iskander, 2nd edition, Waveland Press, 2012. Section of Chapter 4 will also be used to cover the topic of computational techniques. Besides the text material, students will be provided with additional supplemental material whenever needed.

Designation: Elective

Catalog Description: EE 474 Antennas (3) Electromagnetic wave propagation in free space and ionized media. Geomagnetic and solar effects on the ionosphere. Absorption and dispersion. Antenna arrays, apertures, horns, impedance. Design of antenna systems. Pre: 371.

Pre-and Co-requisites: EE 371 (Engineering Electromagnetics I)

Class/Lab Schedule: 3 lecture hours per week

Topics Covered:

This course covers the fundamental concepts of antennas and wireless propagation. The topics covered are

- Electromagnetic spectrum, Maxwell's equations, constitutive relations, Poynting's theorem, timeharmonic fields (3 hrs)
- Plane wave solution, dispersion relation, polarization, waves in materials, boundary conditions, reflection and transmission at media interfaces, Fresnel coefficients, Brewster's angle, total internal reflection (9 hrs)
- Solution to radiation problems, antenna parameters, wire antennas, aperture theory, horns and reflector antennas, phased arrays, effect of ground (image theory), broadband antennas, log-periodic antennas, Yagi-Uda antennas, loop antennas, helical antennas, microstrip antennas (20 hrs)
- Computation techniques for antenna applications, method of moments, solution of Hallen's integral equation and calculation of radiation characteristics of wire antennas (3 hrs)
- Friis transmission formula, receiving properties of antennas, impact of antenna performance in communication links, Friis transmission formula, basic radar principles, numerical techniques for wave propagation and antenna design (5 hrs)

Course Objectives and Their Relationship to Program Objectives:

The main objective is to introduce students to the physical aspects of radiation from wire antennas, describe key parameters in characterizing antennas, and introduce students to various types of antennas and antenna arrays. Beside radiation from wire antennas with and without

parasitic elements, students will learn about antennas with circularly polarized radiation patterns and a variety of antenna designs known as broadband or frequency independent antennas. Use of computational techniques such as the method of moments to calculate radiation characteristics of wire antennas will also be described, and the course will be concluded with a brief introduction to propagation modeling of wireless communication environment [Program Objective this course addresses: 1,2,3,4,5]

Course Outcomes and Their Relationship to Program Outcomes:

The following are the course outcomes and the subset of Program Outcomes (numbered 1-7 in square braces "[]") they address:

- Use of electromagnetics, physics, and mathematics to understand fundamentals of antennas. [1,2, 6, 7]
- Develop the ability to design antennas in wireless communication systems [1, 2, 4, 6, 7]

Contribution of Course to Meeting the Professional Component

Engineering Topics: 100%

Computer Usage:

Computer language programming (Matlab, C++, Fortran, etc.) is important and will be used to realize computational methods (method of Moments) and in developing different antenna designs including frequency independent antennas.

Design Credits and Features:

EE 474 has 1.5 design credits.

Person(s) Preparing Syllabus and Date: Magdy F. Iskander, Jan. 30, 2015. Modified by A. Ohta, Jan. 20, 2021.