# ECE 5011: Antennas

## Course Description

Electromagnetic radiation; fundamental antenna parameters; dipole, loops, patches, broadband and other antennas; array theory; ground plane effects; horn and reflector antennas; pattern synthesis; antenna measurements.

**Prior Course Number:** ECE 711
**Transcript Abbreviation:** Antennas
**Grading Plan:** Letter Grade
**Course Deliveries:** Classroom
**Course Levels:** Undergrad, Graduate
**Student Ranks:** Junior, Senior, Masters, Doctoral
**Course Offerings:** Spring
**Flex Scheduled Course:** Never
**Course Frequency:** Every Year
**Course Length:** 14 Week
**Credits:** 3.0
**Repeatable:** No
**Time Distribution:** 3.0 hr Lec
**Expected out-of-class hours per week:** 6.0
**Graded Component:** Lecture
**Credit by Examination:** No
**Admission Condition:** No
**Off Campus:** Never
**Campus Locations:** Columbus
**Prerequisites and Co-requisites:** Prereq: 3010 (312), or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.
**Exclusions:** Not open to students with credit for 711.
**Cross-Listings:**

**Course Rationale:** Existing course.

**The course is required for this unit's degrees, majors, and/or minors:** No
**The course is a GEC:** No
**The course is an elective (for this or other units) or is a service course for other units:** Yes

**Subject/CIP Code:** 14.1001
**Subsidy Level:** Doctoral Course

## Programs

| Abbreviation | Description |
|---|---|
| CpE | Computer Engineering |
| EE | Electrical Engineering |

## Course Goals

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| Teach students basic antenna parameters, including radiation resistance, input impedance, gain and directivity |
| Expose students to antenna radiation properties, propagation (Friis transmission formula) and wireless point to point communication connectivity requirements |
| Study elementary antennas and their radiation properties |

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| Expose students to impedance matching techniques, and mutual coupling |
| Study antenna arrays and array design methods. |
| Introduce students to commonly used wideband antennas such as spirals and log-periodics |
| Introduce students to aperture antennas such as horns and reflectors |

## Course Topics

| Topic | Lec | Rec | Lab | Cli | IS | Sem | FE | Wor |
|---|---|---|---|---|---|---|---|---|
| Review:  Maxwell?s equations; boundary conditions; complex Poynting vector; real and reactive power; vector and Hertz potentials; radiation integral; duality; reciprocity | 4.0 | | | | | | | |
| Radiation by simple sources; antenna parameters and characterization properties:  radiation resistance, radiation intensity, directivity and gain, effective aperture; Far-zone and Fresnel regions | 5.0 | | | | | | | |
| Elementary antennas and their properties; dipoles; loop antennas | 6.0 | | | | | | | |
| Linear and planar arrays; phased arrays; endfire arrays; Chebychev arrays and design techniques | 7.0 | | | | | | | |
| Impedance matching; mutual impedances | 3.0 | | | | | | | |
| Broadband antennas; matching techniques; folded dipole; helical and Yagi-Uda antennas; spiral and log periodic antennas; traveling wave antennas | 6.0 | | | | | | | |
| Microstrip antennas | 3.0 | | | | | | | |
| Aperture antennas; horns and reflectors; equivalence principle | 6.0 | | | | | | | |

## Representative Assignments

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| Homework 1: problems to review: (a) wave propagation and polarization, (b) plane wave reflection from ground/earth, (c) bands used for wireless communications, TV, Radio and Wi-Fi, (d) student awareness of antennas and wireless communications in their daily life. |
| Homework 2: problems to examine student understanding of basic antenna parameters, including patterns and far field. |
| Homework 3: problems on simple/basic antenna radiation. |
| Homework 4: problems on wireless connectivity of multiple antennas (Fris transmission formula) and radar detection. |
| Homework 5: problems on antenna arrays and their design. |
| Homework 6: problems on impedance matching, folded dipole and helical antennas. |
| Homwork 7; problems on Yagi-Uda and microstrip antennas |
| Homework 8: problems on wideband antennas, aperture antennas or horns |
| Project: 3-week antenna design project; students can be given a design goal for a wireless application in their daily life. Frequency, bandwidth and gain requirements as well as size or application type are specified. Students are then asked to design such an antenna to satisfy pre-specified requirements. |

## Grades

| Aspect | Percent |
|---|---|
| Homeworks delivered by the students | 25% |
| Midterm I | 20% |
| Project or Second Midterm | 20% |
| Final exam | 35% |

## Representative Textbooks and Other Course Materials

| Title | Author |
|---|---|
| *Antenna Theory, Analysis and Design* | C. A. Balanis |

## ABET-EAC Criterion 3 Outcomes

| Course Contribution | | College Outcome |
|---|---|---|
| *** | a | An ability to apply knowledge of mathematics, science, and engineering. |
| * | b | An ability to design and conduct experiments, as well as to analyze and interpret data. |
| *** | c | An ability to design a system, component, or process to meet desired needs. |
| * | d | An ability to function on multi-disciplinary teams. |
| ** | e | An ability to identify, formulate, and solve engineering problems. |
| | f | An understanding of professional and ethical responsibility. |
| ** | g | An ability to communicate effectively. |
| ** | h | The broad education necessary to understand the impact of engineering solutions in a global and societal context. |
| ** | i | A recognition of the need for, and an ability to engage in life-long learning. |
| * | j | A knowledge of contemporary issues. |
| *** | k | An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. |

## CpE ABET-EAC Criterion 9 Program Criteria Outcomes

| Course Contribution | | Program Outcome |
|---|---|---|
| *** | 1 | an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics |
| ** | 2 | an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors |
| ** | 3 | an ability to communicate effectively with a range of audiences |
| | 4 | an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts |
| ** | 5 | an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives |
| ** | 6 | an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions |
| * | 7 | an ability to acquire and apply new knowledge as needed, using appropriate learning strategies |

## EE ABET-EAC Criterion 9 Program Criteria Outcomes

| Course Contribution | | Program Outcome |
|---|---|---|
| ** | 1 | an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics |
| ** | 2 | an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors |
| * | 3 | an ability to communicate effectively with a range of audiences |

| Course Contribution | | Program Outcome |
|---|---|---|
| | 4 | an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts |
| * | 5 | an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives |
| ** | 6 | an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions |
| | 7 | an ability to acquire and apply new knowledge as needed, using appropriate learning strategies |

## Additional Notes or Comments

update prereqs to match university version.

**Prepared by:** Betty Lise Anderson