Master Course Description for EE-464 (ABET sheet)

Title: Antennas: Analysis and Design

Credits: 4

UW Course Catalog Description

Coordinator: Matt Reynolds, Associate Professor, Electrical and Computer Engineering

Goals: To expose students to antenna analysis and design using simulation tools and microwave equipment.

Learning Objectives: At the end of this course, students will be able to:

1. *Understand* the general properties of antennas such as radiation pattern, gain, polarization, bandwidth, and characteristic impedance.
2. *Understand* the performance properties of elementary antennas such as dipole, microstrip, horn, helical, Yagi-Uda arrays, and aperture antennas.
3. *Understand* antennas used in mobile devices including inverted-F and meanderline antennas.
4. *Understand* one- and two-dimensional arrays of antennas.
5. *Understand* how to design antennas using computational electromagnetics tools such as Ansoft Designer, HFSS, EMPro, and NEC.
6. *Design, fabricate, and test* an antenna.

Textbook: Warren L. Stutzman and Gary A. Thiele, *Antenna Theory and Design,* 3rd Ed., Wiley.

Prerequisites by Topic:

Applied Electromagnetics (EE-361) and all its prerequisites; or graduate status.

Topics:

1. Antennas and radiating systems; antenna performance [1.5 weeks]
2. Antenna measurements [1 week]
3. Human EM exposure regulations [0.25 week]
4. Wire radiating systems: short and resonant dipoles; travelling wave antennas [1 week]
5. Microstrip antennas [1 week]
6. Inverted F and meanderline antennas [1 week]
7. Aperture antennas [1 week]
8. Broadband antennas [1 week]
9. Active and parasitic arrays of antennas [1.25 weeks]
10. Project work in class [1 week]

Course Structure: Four lecture hours per week. Approximately eight HW and lab assignments are given over the quarter. A midterm exam is given during the quarter covering antenna theory and applications. The final project deals with design, analysis, fabrication, and testing of antennas, and is a comprehensive summary of the course. Example projects may include one or more of the following: printed Yagi antenna, patch antenna array, inverted-F antenna, helical antenna, quadrifilar helix.

Computer Resources: PCs capable of running Ansoft Designer and HFSS (in ECE Building); or EMPro, or NEC (Sieg Hall). CST Design Studio is permitted but not provided.

Laboratory Resources: Vector network analyzers, signal generators, coaxial cabling, and connectors.

HW and Lab assignments: Most homework and lab assignments will be performed in teams of 2-3.

1. Antenna theory
2. Lab: Computational EM for wire radiating systems
3. Microstrip antenna analysis and design
4. Lab: Computational EM design of microstrip antennas
5. Printed circuit definition of printed antenna
6. Lab: Antenna measurements
7. Antenna array analysis and design
8. Project presentations

Grading:

1. Undergraduates: HW and Lab (40%), Exams (10%), Final Project (50%).
2. Graduate students: HW and Lab (40%), Exams (10%), Final Project (50%), with additional homework and project requirements emphasizing analysis and simulation.

ABET Student Outcome Coverage: This course addresses the following outcomes:

H = high relevance, M = medium relevance, L = low relevance to course.

(1) *An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.* **(H)** The lecture contents, homework assignments, and laboratory assignments include analysis of Maxwell's Equations, electromagnetic radiation, performance parameters of antennas, and the use of modern computational electromagnetic design software.

(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.* **(M)** We will provide an elementary introduction to FCC regulations about permissible EM field exposure of humans from radiating systems.

(3) *An ability to communicate effectively with a range of audiences.* **(M)** Students will present their projects to the class in written and oral form.

(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.* **(L)** [see (2)] We will provide an elementary introduction to FCC regulations about permissible EM field exposure of humans from radiating systems.

(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.* **(M)** Students will perform all laboratory assignments and most homework assignments in teams of 2-3; undergraduate and graduate students will be mixed in teams, as will students with different engineering and science backgrounds (e.g. physics majors)

(6) *An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.* **(H)** Laboratory assignments will require the analysis and understanding of computational electromagnetic simulations, as well as setup and measurement of real antennas.

(7) *An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.* **(H)** Students will need to rely upon information sources beyond those provided in class for success in their antenna designs; they will need to couple computational tools (e.g. Matlab, Python) to automate the analysis of data provided by simulation and measurement. By working in teams, students will also draw upon their collective strengths and abilities.

Prepared by:

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