**Rutgers University, Department of Electrical and Computer Engineering**
**ABET COURSE SYLLABUS**
**COURSE: 14:332:481**

**Course Catalog Description:** 14:332:481 Electromagnetic Waves (3)

**Pre-Requisite Courses:** 14:332:382

**Co-Requisite Courses:** None

**Pre-Requisite by Topic:**

1. Electromagnetic Fields
2. Differential Calculus
3. Integral Calculus
4. Matrices and Determinants

**Textbook & Materials**: M.N.O. Sadiku, *Elements of Electromagnetics*, 4th edition, Prentice-Hall, 2007

**References:** None

**Overall Educational Objective:** 1. To introduce the student to the theory and concepts of electromagnetic waves, and their practical applications in communication, medicine, and optical fibers.

**Course Learning Outcomes:** A student who successfully fulfills the course requirements will have demonstrated:

1. An in depth analysis of the solutions and physical Interpretation of Maxwell's equations in the static, steady state and dynamic regimes.
2. An ability to write the constitutive relations and solve the wave equation in both isotropic and anisoropic media.
3. An in depth understanding of polarization and its applications; as well as the theory and design of polarizers, optical transformers, retarders, etc.
4. An in depth analysis of the propagation of plane waves in lossless and lossy dielectric and conducting media.
5. An ability to design devices using the reflective and transmissive properties of media with multiple interface.
6. An in depth analysis of transmission lines and their parameters using the Smith Chart for time-harmonic, transient and pulse propagation.
7. An ability to analyze and design rectangular waveguides and understand the propagation of electromagnetic waves.

**How Course Outcomes are Assessed:**

HW Problems (10%)
Design Projects (20 %)
Two Mid-Term Exam (40 %)
Final Exam (30 %)

**N = none S = Supportive H = highly related**

| **Outcome** | **Level** | **Proficiency assessed by** |
|---|---|---|
| (a) an ability to apply knowledge of Mathematics, science, and engineering | H | HW Problems, Projects, Exams |
| (b) an ability to design and conduct experiments and interpret data | S | Design problems in HW, Projects and Exams |
| (c) an ability to design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability | H | Design Projects |
| (d) an ability to function as part of a multi-disciplinary team | N | |
| (e) an ability to identify, formulate, and solve ECE problems | H | HW Problems, Projects, Exams |
| (f) an understanding of professional and ethical responsibility | S | Lectures, Projects |
| (g) an ability to communicate in written and oral form | S | HW Problems, Project Presentation |
| (h) the broad education necessary to understand the impact of electrical and computer engineering solutions in a global, economic, environmental, and societal context | S | Lectures, |
| (i) a recognition of the need for, and an ability to engage in life-long learning | S | Lectures, subsequent courses |
| (j) a knowledge of contemporary issues | S | Lectures |
| (k) an ability to use the techniques, skills, and modern engineering tools necessary for electrical and computer engineering practice | H | HW and Design Projects |
| Basic disciplines in Electrical Engineering | H | HW, Projects, Exams |
| Depth in Electrical Engineering | S | HW, Projects, Exams |
| Basic disciplines in Computer Engineering | N | |
| Depth in Computer Engineering | N | |
| Laboratory equipment and software tools | S | MATLAB and EESoft |
| Variety of instruction formats | S | Lectures, Problem sessions, Office hour discussions, Project Presentations |

**Topics Covered week by week:**

**Week 1:** Review of Mathematical Concepts: Complex algebra and phasors; time averages.
**Week 2:** Review of Maxwell's equations; Physical interpretation of Maxwell's equation: static, steady state and dynamic regimes.
**Week 3:** Constitutive relations; Maxwell's equations in material media.
**Week 4:** The wave equation in Isotropic Media: Empty space, free space, lossless media and lossy media.
**Week 5:** The wave equation in Isotropic Media: Uncharged and charged media; conducting and non-conducting media.
**Week 6:** Polarization: Linear, circular and elliptical; handedness and helicity.
**Week 7:** Mid-term Exam. Time-Harmonic Waves.
**Week 8:** Electromagnetic wave characteristics; plane waves in lossless and lossy media.
**Week 9:** Power, Poynting Theorem and Poynting Vector.
**Week 10:** Boundary Conditions; Reflection and transmission coefficients; standing-wave ratio; power relations at the interface.
**Week 11:** Reflections and transmissions at multiple interfaces; quarter- and half-wavelength transformers; Snell's Laws; Fresnel's equations; Critical Angle, Brewsler's Angle; Total Reflection.
**Week 12:** Mid-term Exam. Transmission line parameters; Transmission line equations; Transient and pulse propagation.
**Week 13:** Impedances; Reflection coefficient, VSWR and Power; Smith Chart; cascaded transmission Lines.
**Week 14:** Rectangular waveguides; TE and TM modes; Wave propagation in the guide.
**Week 15:** Dielectric losses and conduction losses, $TE_{10}$ mode.
**Week 16:** Final Examination

**Computer Usage:** Simulations using MATHLAB and EESoft.

**Laboratory Experiences:** None.

**Design Experiences:** ~60% Homework problems are design-oriented problems.

**Independent Learning Experiences:** 1. Home-Work, 2. Design Projects 2. Exams

**Contribution to the Professional Component:**
(a) College-level mathematics and basic sciences: 0.25 credit hours
(b) Engineering Topics (Science and/or Design): 2.75 credit hours
(c) General Education: 0 credit hours
Total credits: 3
**Prepared by:** S. R. McAFEE
**Date:** August 2007