EEO323: Electromagnetics

Fall 2016

2016-2017 Catalog Description:

Fundamentals of electromagnetic fields, Maxwell's Equations, plane waves, reflections. Application to transmission lines, propagation, electromagnetic sensors and transducers

Course Designation: Required

Text: Fundamentals of Applied Electromagnetics (7th Edition, 2014)
Fawwaz. T. Ulaby and Umberto Ravaioli

Prerequisites: Calculus III, Physics I and II, Circuits

Instructor: **Charles R. Westgate**

Goals: To teach students the fundamentals of electromagnetism and relate them to circuits and circuit elements, high frequency propagation, motors and generators, wave propagation, and applications to modern devices utilizing electromagnetic effects.

Objectives: Students will be able to:

- Analyze electrostatic and magnetostatic fields
- Determine when transmission line effects must be taken into account
- Analyze circuits with transmission line components
- Determine how high frequencies change circuit analysis
- Solve for electric and magnetic field distritbuitons
- Calculate capacitance, inductance of circuit elements
- Analyze time dependent circuits including induced voltages
- Apply electromagnetics to current applications including RFID's
- Solve propagating wave problems

Topics Covered:

Week 1.	Importance of electromagnets and high frequency circuits. The electromagnetic spectrum. Propagating waves and phasors. Coulombs law and fields. Units.
Week 2.	Transmission line models. The lossless line. Propagating waves and characteristic impedance. Reflection coefficient.
Week 3.	Solution of the complete transmission circuit with load and source. Representation of reflection coefficients and impedance. Standing waves. Measurements. Matching. Pulse response.
Week 4.	Test 1 on Weeks 1-3. Electrostatics. Vector representation and coordinate systems. Coulombs law, spherical coordinate systems. Forces and Electric Field (Coulomb's law).
Week 5.	Charges and charge distributions (line and volume charges). Electrical

	potentials. Electric flux density and divergence. Dielectrics. Boundary conditions.
Week 6.	Gauss's Law, capacitance, coaxial cable capacitance per unit length. Conductivity, current flow, Ohm's Law, Kirchhoff's Laws.
Week 7.	Magnetostatics. Forces on moving charges and cross product. Hall Effect. Biot-Savarat's equation. Forces on wires carrying currents.
Week 8.	Ampere's Law, curl, magnetic flux density, Stokes' Theorem, magnetic torque and electric motors.
Week 9.	Test 2 on Weeks 4-7. Inductors, inductance of a coaxial cable and twin lead. Magnetic materials and boundary conditions.
Week 10.	Dynamic fields. Maxwell's equations in point and integral form. Transformers. Faraday's law. Generators. Applications including RFID's
Week 11.	Displacement current, capacitors, current continuity, relaxation times. Time harmonic fields, motional EMF
Week 12.	Plane wave and wave propagation. Polarization. Reflection at surfaces, total internal reflection, critical angles.
Week 13.	Impedance of free space, losses in dielectrics, skin effect, relationships to transmission lines, Poynting vector and power
Week 14.	Review and Test 3 on Weeks 10-13

Class/laboratory Schedule: Online lecture modules and online office hours each week

Student Outcomes and Assessment	**% contribution**
✓ (a) an ability to apply knowledge of mathematics, science and engineering	100
❑ (b1) an ability to design and conduct experiments	
❑ (b2) an ability to analyze and interpret data	
❑ (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	
❑ (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, economic, environmental, 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	
❑ (l) An ability to communicate and/or collaborate effectively online	

Document Prepared by: Charles Westgate on 6/27/2017