Course (Catalog) Description: Introductory course in electromagnetism and its application in electric engineering. Analytic and numerical solutions of boundary value problems. Advance transmission lines, waveguides, antennas, radiation and scattering. Lecture, laboratory.

Prerequisite: EEE 340.


Coordinator: George W. Pan, Professor; James Aberle, Associate Professor; Elsharawy Elbadawy, Associate Professor

Computer Usage: MATLAB, Magicad, Sonnet.

Prerequisites by Topic:
1. Circuit and network theory
2. Differential equations
3. General physics

Course Objective:
1. Students are proficient in analytic and computational analysis, and in high frequency measurements

Course Outcomes:
1. Students acquire knowledge and intuition of wave and quantum phenomena in contrast to Newtonian mechanics
2. Students can analyze basic microwave/distributed circuits, radiation and scattering system
3. Students can solve practical packaging and interconnect problems with MagiCad
4. Students can conduct RF and microwave measurements

Course Topics:
1. Plane electromagnetic waves (Chapter 8)
2. Lossless and lossy TEM waves
3. Polarizations
4. Normal and oblique incidence at PEC and dielectric boundaries
5. Total reflection and total transmission with applications in fiber optics
6. Transmission Lines (Chapter 9)
7. Single lossless and lossy transmission lines (frequency domain)
8. Transient analysis on transmission lines (time domain)
9. Smith chart
10. Transmission line matching: single stub match, $\lambda/4$ transformer
11. Coupled multi-transmission lines
12. Matrix-vector telegrapher’s equations
13. MagiCad simulation of crosstalk and multi-reflections
14. Waveguides and Resonators (Chapter 10)
15. TM and TE modes
16. Dielectric waveguides
17. Rectangular cavity resonators: modes and quality factor
18. Antennas and Radiation systems (Chapter 11)
19. Hertz electric and magnetic dipoles
20. Linear antennas
21. Aperture antennas
22. Antenna parameters: near-field measurements and Sonnet simulation
23. Antenna arrays
24. Transmit-receive system
25. Radar equation

A class project, “Parasitic distribution parameter extraction and waveform simulation for GHz digital systems,” is assigned, requiring the use of MagiCad.

Laboratory Experiments:
Students meet weekly for a three-hour laboratory under the guidance of a TA.
1. TDR (time-domain reflectometry)
2. Laser reflection and transmission
3. Vector network analyzer
4. Antenna near-field measurements
5. Modes in waveguides
6. Simulation of microstrip filter
7. Probe-station S-parameter

Course Contribution to Engineering Science and Design:
EEE 440 contributes to engineering science through applications of mathematics and physics, circuit and system analysis, problem solving, computer simulations, and project assignment.

Course Relationship to Program Objectives:
A.1: MagiCad and Sonnet software, and modern laboratory equipment, and contemporary field analysis techniques.
A.4: Limited applications.
B.1: Inspired by some instructors to pursue electrical engineering degree and graduate study.
C.1: Basic high frequency circuit analysis is a fundamental skill needed in industry.
D.1: Students are taught problem solving beyond ‘instantaneous’ and ‘continuous’ concepts.
D.2: Limited modeling.
D.3 and 3(a), 8: partial differential equations and physics backgrounds are utilized.
D.4 and 3(k): MagiCad and Sonnet software are used.
D.5: Course topics are fundamental to electrical technology, especially in high-speed digital and wireless applications.
3(b): Significant laboratory experience.
3(d): Helps students in their feature study of quantum mechanics, solid states, optics and computational modeling and simulation.
3(e): Students are solving engineering and science problems.

Person preparing this description and date of preparation: George Pan, Mar. 2003.