ELEG ELEG 4703 - RF & MICROWAVE DESIGN
TECHNICAL ELECTIVE

Credits and Contact Hours

Three credit hours, XX hours of instructor contact

Instructor's Name

Magda El-Shenawee

Textbook
Microwave Engineering, D. M. Pozar, John Wiley & Sons, Inc. 2005

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Catalog Description

An introduction to microwave design principles. Transmission lines, passive devices, networks, impedance matching, filters, dividers, and hybrids will be discussed in detail. Active microwave devices will also be introduced. In addition, the applications of this technology as it relates to radar and communications systems will be reviewed. Design of passive components analytically and using the electromagnetic simulator (ANSOFT Designer). Photolithography fabrication of designed component and S-parameters measurements using Network Analyzer.

Prerequisite: ELEG 3704.

~~**Textbook**~~
~~Microwave Engineering, D. M. Pozar, John Wiley & Sons, Inc. 2005~~

Prerequisites by Topics

1. Maxwell's equations
2. Boundary conditions for electric fields
3. Boundary conditions for magnetic fields
4. Vector analysis and integration
5. Divergence and Stocks Theorem and the Image Theory
6. Transmission line Theory

Course Objectives

After completing this course, electrical engineering students should be able to learn the following:

- Gain an introduction to microwave & RF design principles, simulation and testing
- Design aspects of special transmission lines such as microstrip and strip lines
- Gain an introduction to passive components such as filters, couples, dividers, etc
- Practice on impedance matching using the quarter wavelength transformer
- Design of passive components analytically and using the electromagnetic simulator (ANSOFT DESIGNER).
- Understand the photolithography to fabricate designed component (coupler, power divider, filter, etc.)
- Understand the function of the Network Analyzer and use it for S-parameters measurements.

Topics

1. Review Maxwell's Equations and Boundary Conditions (3 classes)

2. Transmission line Theory, Lumped-Element Circuit Model, The Terminated Lossless Line, The Quarter–Wave Transformer, Generator and Load Mismatch, Lossy-Transmission Line, Power flow on a lossless Transmission Line. (5 classes)
3. Microstrip and strip transmission lines (2 class)
4. Microwave Network Analysis, impedance and equivalent network Analysis, impedance and Admittance Matrices, the Scattering Matrix, the transmission ABCD matrix, and signal flow graph. (5 classes)
5. Impedance matching and tuning, matching with Lumped Elements, single-stub tuning, double-stub tuning, the quarter-wave transformer, the theory of small reflections (4 classes)
6. Microwave Resonators (1 class)
7. Power Dividers and Directional Couplers (2 classes)
8. Microwave Simulator (ANSOFT Package) and practice (3 classes in computer lab)
9. Fabrication in the photolithography lab (2 classes)
10. Microwave Measurements in the Network Analyzer Lab (2 classes)
11. Final project discussion (1 class)
12. Examinations (2 take home projects)

There are two (2) 80-minute class periods per week for a total of 15 weeks.

Computer Usage

- Extensive training on the Ansoft Simulator Package in design problems
- The students are required to use the computers to plot their results in project reports

Oral/Written Communications

Not addressed

Design Activities

The students will do several design problems of transmission lines, matching, devices using the Ansoft Simulator. Standard passive components such as coupler, filter, power divider, etc will be designed in class.

Relationship of Course to ABET Program Outcomes

OUTCOME	HOW IT WAS ADDRESSED
(a)	Ability to calculate the reflection coefficients S-parameters, Z-elements of the impedance matrix, the average power delivered by the generator, losses in the network through the S-parameters.
(b)	Ability to use ANSOFT DESIGNER to design a passive microwave component (coupler, divider, filter, etc.) and ability to use the material data sheet obtained from the manufacturer. Ability to conduct actual measurement of the S-parameters of designed and fabricated component. Ability to analyze the actual performance of the microwave component compared with the designed one.
(c)	Ability to design several passive devices such as the quarter wave transformer, the microstrip lines with specific characteristic impedance, and matching networks
(d)	Not addressed
(e)	Ability to address the practical problem of mismatch between the transmission lines and the load (device). The students are getting training to design matching networks to overcome the mismatch.
(f)	Not addressed
(g)	Not addressed
(h)	Understand the relationship between the subject of microwave circuits as related to everyday life through the use of electronic devices such as cell phones. These issues are often discussed when designing the microwave components and showing its performance.
(i)	Not addressed

(j)	Not addressed
(k)	Ability to be trained on using the microwave simulator (ANSOFT DESIGNER) that is a major part of class. Using the DESIGNER is a highly preferred skill for RF engineers.

Professional Components

Professional Components

Mathematics: 30%
Sciences: 5%
Engineering Science: 10%
Engineering Design: 50%
General Education: 5%

Prepared by: Magda El-Shenawee **Date: October 2013**