463mcd2025

Master Course Description for EE-463 (ABET sheet)

Title: Microwave Electronic Design

Credits: 4

UW Course Catalog Description

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

Goals: To expose students to microwave circuit analysis, design, fabrication, and testing.

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

1. *Understand and use* microwave CAD software and measurement techniques.
2. *Design* simple passive and active microwave circuits.
3. *Design, fabricate, and test* a microwave amplifier.

Textbook: D. Pozar, *Microwave Engineering, 4th Ed.,* Wiley, 2012, ISBN 978-0-470-63155-3

References:

1. Lecture notes
2. Lab handout
3. AWR Microwave Office references

Prerequisites by Topic:

1. Electromagnetic theory of transmission lines
2. Smith chart and matching techniques
3. Basic circuit analysis

Topics:

1. Introduction to microwave transmission lines and matching techniques (1.5 week)
- Microstrip transmission lines
- Single and double stub tuning circuits
- Quarter-wave impedance matching circuits
3. Quadrature and 180 degree hybrid analysis and design (2 weeks)
- Even- and odd-mode analysis of hybrids
- Reciprocal and lossless networks
- Cascaded network using ABCD parameters
- Frequency responses
5. Low-pass and high-pass filter analysis and design (2 weeks)
- Filter design by insertion loss method

- Stepped impedance filter
- Filter transformation
- Filter implementation using microstrip lines

7. Noise analysis (1.5 week)

- Noise in devices and systems
- Noise figure and noise temperature
- Non-linear responses of microwave circuits

9. Design and fabrication of a microwave amplifier (2 weeks)

- Gain and stability analysis
- Input and output matching circuits
- Dynamic range, noise and non-linearity

11. Microwave systems (1 week)

- Radar
- Radiometers
- Microwave communication systems

Course Structure: Lectures are organized so that the students can analyze and design the passive and active microwave circuits assigned for each lab project. The first two weeks cover basic transmission line theory and S-parameter analysis. The following eight weeks are divided into lab projects and a final project. Each project starts with analysis followed by simulations using CAD programs. Students must also fabricate the circuits and evaluate the performance.

Laboratory projects:

1. Lab1 - Introduction to network analyzers

- One- and two-port calibration techniques
- Time- and frequency-domain analysis
- Unknown impedance measurements

3. Lab 2 - Matching circuit design by AWR Microwave Office (CAD)

- Single- and double-stub matching circuit design using CAD
- Smith chart analysis
- Circuit optimization using AWR Microwave Office (CAD)

5. Lab 3 - Quadrature hybrid design and fabrication

- Design of a 90-degree or 180-degree hybrid
- Circuit fabrication using a CAD program and copper tape
- S-parameter measurements using a network analyzer

7. Lab 4 - Low-pass filter design and fabrication

- Design of Butterworth, Chebysheb, Stepped impedance LPFs
- Circuit fabrication using a CAD program and copper tape
- S-parameter measurements using a network analyzer

9. Final Project: Amplifier design and fabrication

- Narrow-band amplifier design using Designer

- Circuit fabrication using a CAD program
- Gain measurements using a network analyzer
- Stability check and dynamic range measurements

Computer Resources:

1. AWR Microwave Office microwave circuit design software
2. KiCAD Layout CAD program

Laboratory Resources:

1. Vector network analyzer
2. Other microwave equipment:

- Spectrum analyzer
- Signal generator
- Noise source

Grading: 50% take-home HW/Lab, 50% final project

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

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

(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.* **(H)** Students use microwave CAD software (AWR Microwave Office) and modern microwave measurement systems (network analyzer, signal generators, spectrum analyzer). Similar equipment and software are widely used in industry. The instructor will discuss the professional ethics and responsibility in class.

(3) *An ability to communicate effectively with a range of audiences.* **(H)** Students must prepare extensive written project reports. Grades are given for writing quality as well as technical content of the reports.

Prepared by: Matt Reynolds (earlier versions by Yasuo Kuga)

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