Course Name: RF and Microwave Design, EE 444
Instructor: Dr. Loren Betts
E-mail: loren.betts@sonoma.edu
Course page: https://canvas.instructure.com/courses/1511588

Class Schedule (Salazar 2009A): Monday/Wednesday: 4:00pm to 5:15pm.

Office Hours: By Appointment.


Course Description: Fundamentals of RF and microwave circuit design including transmission line theory and vector network analysis theory and measurements. CAD tools are used for RF design and simulation.

Assignments: Assignments will consist of written homework as well as ADS (Advanced Design System) simulations. Assignments are due at the beginning of lecture and no late assignments will be accepted. Please show all work!

Project: There will be one class project that will require the use of ADS; and generation of a report to be submitted for grading.

Exams: There will be one mid-term exam and one final exam. See the Canvas schedule of homework assignments for the due dates and the chapters covered for each exam.

Canvas: I am not normally located on campus, so Canvas will be a great resource for this class. I will post homework assignments, homework solutions, lecture notes, calendar information, and additional resources on this website. It is required that you use Canvas. It will be the primarily location for class announcements, schedule changes, etc. If you have not received an invitation from me, please let me know immediately.

Grade: Assignments 20%
Project 40%
Mid-term Exam 20%
Final exam 20%
Class Outline: Here is an outline of the units we will be covering. These are subject to change.

1. Definition of Units

2. Transmission Line Theory
   a. Distributed-Element Model
   b. Lossless Transmission Line
   c. Wave Equations
   d. Characteristic Impedance
   e. Termination of a Transmission Line
      i. Reflection Coefficient, Average Power, Return Loss, Voltage
         Standing Wave Ratio (VSWR, SWR)
      ii. Reflection Coefficient vs Distance
      iii. Input Impedance vs Distance
      iv. Two Transmission Lines
   f. Generator and Load Mismatches

3. Microwave Network Analysis Theory and Measurements
   a. Smith Chart
   b. Linear Parameters
      i. Impedance
      ii. Admittance
      iii. Scattering (S-parameters)
   c. Vector Network Analysis (VNA)
   d. Nonlinear Scattering Parameters
      i. X-Parameters
   e. Nonlinear Vector Network Analysis (NVNA)
   f. Lossy Transmission Line
   g. Generator and Load Mismatches

No classes: March 18 - 22 (Spring break)
April 1 (Cesar Chavez day)

Key Dates: TBD (Mid-term exam)
May 15 (Final exam)
Course Learning Objectives (CLO):

1. Understand the voltage, current, and impedance characteristics on a transmission line
2. Learn the transmission line wave equations and their relationships to current, voltage and impedance on a transmission line
3. Understand the relationship between the transmission line wave equations and the load and source impedance
4. Learn the linear models for RF and microwave components (Z, Y, and S-parameters)
5. Learn the nonlinear models for RF and microwave components (X-parameters)
6. Practice CAD tools to simulate RF and Microwave circuits

Course Outcomes (CO):

1. Know how to calculate the voltage, current and impedance on a transmission line as a function of distance
2. Know how to properly terminate a transmission line
3. Know how to calculate the characteristics of a transmission line between a source and a load
4. Know how to calculate linear models of RF and microwave circuits
5. Know how to use Advanced Design System (ADS) to design and simulate a matching network
### Student Learning Outcomes vs. Course Learning Objectives:
(Support Level (0-5) 0=No support, 1=lowest support, 5=highest support)

<table>
<thead>
<tr>
<th>ABET Student Outcomes</th>
<th>CLOs</th>
<th>Level of Support</th>
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<tbody>
<tr>
<td>(a) an ability to apply knowledge of mathematics, science, and engineering</td>
<td>2, 4</td>
<td>4</td>
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<td>(b) an ability to design and conduct experiments, as well as to analyze and interpret data</td>
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<td>(c) an ability to design a system, component, or process to meet desired needs</td>
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<td>(d) an ability to function on multi-disciplinary teams</td>
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<td>(e) an ability to identify, formulate, and solve engineering problems</td>
<td>2, 4, 5</td>
<td>4</td>
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<td>(f) an understanding of professional and ethical responsibility</td>
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<td>(g) an ability to communicate effectively</td>
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<td>(h) the broad education necessary to understand the impact of engineering solutions in a global and societal context</td>
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<td>(i) a recognition of the need for, and an ability to engage in life-long learning</td>
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<td>(j) a knowledge of contemporary issues</td>
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<td>(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice</td>
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<td>(l) a knowledge of probability and statistics, including applications appropriate to Electrical Engineering program.</td>
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<td>(m) a knowledge of advanced mathematics through differential and integral calculus, linear algebra, complex variables, and discrete mathematics.</td>
<td>1, 2, 4, 5</td>
<td>3</td>
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<tr>
<td>(n) a knowledge of basic sciences, computer science, and engineering sciences necessary to analyze and design complex electrical and electronic devices, software, and systems containing hardware and software components, as appropriate to Electrical Engineering program</td>
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<td>4</td>
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### Assessment Methods:

**Assessment of the student learning**

1. Student assignments
2. Quizzes, Midterm and Final exams

**Course quality Assessment**

1. Student survey of the course
2. Peer instructors feedback