ECE4415 Course Syllabus

ECE4415

RF Engineering I (3-0-0-3)

CMPE Degree
This course is Elective for the CMPE degree.

EE Degree
This course is Elective for the EE degree.

Lab Hours
0 supervised lab hours and 0 unsupervised lab hours

Course Coordinator
Kenney,James Stevenson

Prerequisites
ECE3025 [min C] and ECE3050/3400

Corequisites
None

Catalog Description
Radio frequency (RF) electronics concentrating on receiver components and architecture from 1 MHz to 1 GHz, including Smith charts, low noise amplifiers, and mixers.

Textbook(s)
Guillermo Gonzalez, *Microwave Transistor Amplifiers Analysis and Design* (2nd edition), Prentice Hall, 1997. ISBN 0132543354, ISBN 9780132543354 (required)

Thomas H. Lee, *Planar Microwave Engineering*, Cambridge University Press, 2004. ISBN 0521835267 (required)

Course Outcomes
Upon successful completion of this course, students should be able to:
1. Design matching networks using the Smith chart
2. Model transistors for small-signal operation
3. Analyze noise contribution from components
4. Design, simulate, fabricate and test a multi-stage LNA
5. Design, simulate, fabricate and test a double-balanced mixer

Student Outcomes
In the parentheses for each Student Outcome:
"P" for primary indicates the outcome is a major focus of the entire course.
“M” for moderate indicates the outcome is the focus of at least one component of the course, but not majority of course material.
“LN” for “little to none” indicates that the course does not contribute significantly to this

outcome.

1. (P) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. (LN) 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
3. (LN) An ability to communicate effectively with a range of audiences
4. (LN) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. (P) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. (P) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. (LN) An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Topical Outline

- Introduction
  - Analog vs. RF Engineering
  - Systems and Circuits
  - High Frequency Measurements
- Circuit Fundamentals
  - Sources and Available Power
  - Balanced (Differential) vs. Unbalanced (Single-ended) Networks
  - Y, Z, ABCD, and s-parameter Two-Ports
  - Transmission Line Analysis using the Smith Chart
  - L/C/T Lossless Matching Network Design
- Losses, Resonant Circuits, and Bandwidth
  - Practical Limitations of Lumped Element Components
  - Planar Transmission Lines and their Limitations
  - Resonant Circuits and Quality Factor (Q)
  - Bandwidth and Attenuation
  - Resistive Attenuators and their Uses
- Practical Lumped-Element Filter Design
  - Low-Pass and High-Pass Filters
  - Bandpass Filters
  - Notch Filters
- Active Device Modeling
  - Hybrid-Pi model at High Frequencies
  - Package Models
  - s-parameter Models
- Amplifier Fundamentals
  - Amplifier Topologies
  - S-parameter Design of RF Amplifiers
  - Gain and Stability Circles
  - Power Gain
  - Maximum Stable Gain
- Noise Analysis
  - Noise Mechanisms in Devices
  - Noise Factor and Noise Figure
  - Noise Models for Active Devices