



# WISCONSIN

## UNIVERSITY OF WISCONSIN-MADISON

University of Wisconsin - Madison  
College of Engineering [EGR]  
Last Offered: 2014 Fall [1152]  
Direct Link to this Syllabus :

<http://aefis.engr.wisc.edu/index.cfm/page/CourseAdmin.ViewABET?coursecatalogid=292&pdf=True>

1. **E C E 447, Applied Communications Systems**
2. **Credits : 3    Contact Hours : 2.5**
3. **Textbook and Materials :** Microwave Transistor Amplifiers: Analysis and Design; Gonzalez; 2; 1997  
Microwave Engineering; Pozar; 4; 2011

**a. Other Supplemental Materials :**

Additional notes

• **Specific Course Information :**

- a. **Brief description of the content of the course (Course Catalog Description) :** Analysis with design problems of electronic communications circuits. Emphasis on the nonlinear effects of large-signal operation of active devices. Complete design of r.f. oscillator, amplifier, and mixer circuits.
- b. **Pre-requisites or Co-requisites :** ECE 340; ECE 420 recommended
- c. **This is a Selected Elective course.**

• **Specific Goals for the Course :**

**a. Course Outcomes :**

1. This course draws on electromagnetic theory for transmission lines, device physics for linear and nonlinear transistor models, time- and frequency-domain measurements, and industrially-relevant CAD software for a comprehensive introduction to time- and frequency-domain IC concepts in the picosecond/GHz regime. The course lays the foundations of understanding and designing hardware for wireless communications systems.
2. Students will gain understanding of high frequency (microwave) components for communication, measurement, and sensing systems. By alternating between high- and low-level discussions, analysis and design of a wide variety of microwave elements, components, subsystems and systems, the instructor seeks to maintain rigor at the fundamental level while continuously placing these details in the context of the above-mentioned systems.
3. By the end of the course, students will be conversant in microwave element, component, subsystem and system terminology, understand the advantages and limitations of different design approaches, and be able to draw upon a wide range of tools, both analytical and numerical, to solve microwave circuit design problems. Each student will have proposed, designed, analyzed, and simulated an industrially-relevant component such as a coupled line filter, mixer, amplifier, oscillator, or simulation tool while presenting intermediate and final results to the rest of the class.

• **ABET Student Learning Outcomes :**

- (a) Ability to apply mathematics, science and engineering principles.
- (c) Ability to design a system, component, or process to meet desired needs.
- (e) Ability to identify, formulate and solve engineering problems.
- (g) Ability to communicate effectively.
- (k) Ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

• **Brief List of Topics to be Covered :**

1. Review of transmission line fundamentals
2. Analysis, discussion and design of planar transmission line structures
3. Review of network parameters, emphasizing scattering (S) parameters
4. Review of the Smith chart
5. Discussion of microwave measurements
6. Analysis, discussion and design of planar (coupled line) filters, transitions, vias, couplers, matching networks
7. Analysis and discussion of diodes as varactors, detectors, switches
8. Discussion of transistors: GaAs FETs, Si BJTs, and use of CMOS at microwave frequencies
9. Analysis and discussion of small-signal amplifiers, both narrowband and broadband (low noise, high gain, balanced, traveling wave); design of narrowband amplifiers
10. Discussion of power amplifiers
11. Analysis and discussion of oscillators, both fixed and tunable (cavity, VCO, YIG); design of fixed oscillators
12. Analysis and discussion of mixers
13. Discussion of subsystems and other components, e.g. phase shifters, samplers, heterodyne techniques, frequency synthesis
14. Discussion of systems, e.g. communication, radar, sensors
15. Discussion of current topics, e.g. field measurement/calculation,
16. optoelectronic modulators and detectors, low-power CMOS circuits, device modeling (both linear and nonlinear)
17. Further topics for discussion: time-domain reflectometry; network analyzers, both scalar and vector; assembly, probing and packaging techniques
18. Final design project, incorporating design, analysis, CAD, and reporting