ECE 453 - Wireless Communication Systems

Instructors:

Professor Franke is both the course director as well as the lecturer. Professor Minin is the lab director.

Prerequisites:

The official prerequisites are credit for ECE 329 and credit or concurrent registration in ECE 342. While there are few topics in this class that require ECE 329, it is necessary to understand the context in which these systems exist. Concurrent registration or credit in ECE 342 is necessary because topics such as amplifiers and oscillators rely heavily the transistor circuit models learned in ECE342, as well as familiarity with small signal analysis.

When to Take It:

Take this class if you wanted to delve deeper in the ECE 210 lab, which demonstrated a basic AM radio receiver; ECE 453 is a more involved study of such communication systems. This class is a must if you intended to go into wireless communications of any kind. Most of the students in the class are juniors and seniors. It is offered every semester.

Class Content:

The class starts with modulation, both AM and FM. Comparisons are made between the bandwidths, efficiency, and ease of modulation/demodulation. It quickly moves to how the superheterodyne receiver works, how to change the frequency of incoming signals to make them easier to demodulate, and the effects of spurious responses. The next topic is RLC networks, which covers the quality factor of a network, and series/parallel impedance transformations that will become useful when discussing impedance matching. Oscillators are also covered, particularly the Colpitts configuration. A large portion of time near the end of the semester is devoted to introducing 2 port parameters, with S parameters in particular. A lot of analysis is done using S parameters, which is used to find things like input impedance and the various gains. Lastly, noise and non-linear effects are covered to show the limitations of receiver capability and design trade-offs.

The lab section covers almost every topic discussed in lecture, and then some. Particularly, besides learning how the impedance and spectrum analyzers how, much detail is gone into on PCB and component design in the RF spectrum learning how resistors, capacitors, inductors, and crystals behave across the frequency spectrum. You will learn how to use signal and network analyzers to measure frequency responses and reactive/inductive responses. The lab is as much a circuit design and construction subcourse; oscillator, amplifier, and filter circuits are designed and soldered by you into perfboards or specially designed PCBs.

Work:

The class consists of 2 midterms and a cumulative final. These exams make up the majority of the grade. There is usually homework due each week that consists of problems from the course notes and occasionally a new problem written by Professor Franke. They may require the use of software such as ADS and Matlab, which are both available on the EWS computers. Homework usually takes between 4-7 hours to complete, with much of the time spent on unraveling the math of circuit analysis. Additional study is suggested since concepts such as two-port parameters are difficult to learn from just the homework alone.

The lab meets weekly for 3 hours. There are no written prelabs, but there are prelecture videos provided by the lab instructor to watch. There are 4 lab reports due throughout the semester. Plan to spend 10-20 hours on each lab report. Following that, there is a self-decided final project for the last lab investigating concepts learned in lab.

Life After:

ECE 453 is a prerequisite for ECE 447, Active Microwave Circuit Design. This class is essential to understanding the basics of modern wireless communications. The analysis of RF circuits across frequency ranges makes this a suggested prerequisite for ECE 451, Advanced Microwave Measurements. Anyone looking to work in analog circuit design of any kind will benefit from taking this class.