**ECE 451 - Advanced Microwave Measurements**

**Instructors:**

Professor Jose Schutt-Aine is both the course director and the primary lecturer. The course website is available [here](#).

**Prerequisites:**

The only prerequisite is ECE 360, but it may be useful to take other classes such as ECE 453, ECE 457, or ECE 447, due to the overlap in some concepts like S-parameters and transmission line analysis. Many transmission line concepts from ECE 329 are heavily used throughout the course.

**When to Take It:**

Most students take this lab course during their junior or senior years. It is not necessary to take it right away, but the lab skills may be useful for finding RF related internships. It is typically offered in the fall semester.

**Class Content:**

The lectures start out with a review of transmission line concepts, including Smith Chart usage. S-parameters are quickly introduced, and are combined with the flow graph representation to derive various error models used in RF measurements and calibration. From there topics like extraction of transmission line parameters, calibration methods, time-domain reflectometry, on-chip measurements, and eye diagrams are covered. Many lectures are devoted to power amplifier analysis to introduce non-linearity and measurement techniques for non-linear systems. Finally, X-parameters are introduced to deal with non-linear measurements. X-parameters are a new addition to the class, and it being taught in an undergraduate level class is fairly unique in electrical engineering programs.

**Work:**

ECE 451 is primarily a lab course. There are weekly labs, each with a lab report due the following week. Labs typically involve either taking measurements on a network analyzer or using Agilent ADS software. There may or may not be prelabs due before each lab session. Lab reports are fairly involved, and are a determining factor in your final grade. Expect to spend 5+ hours working on the lab reports for each week.

There is homework due every couple of weeks that cover lecture topics, but is fairly straightforward and not too challenging. There is a midterm and a final, both in-lecture.

**Life After:**

The hands on nature of this class makes it a great class for students looking for jobs or internships in RF circuits and high frequency measurements. Some companies include Motorola, Freescale, Silicon Labs, Intel, National Instruments, Apple, Qualcomm, etc. Students who enjoyed the class should consider other courses in the 450 series in the ECE department. ECE 457 covers transmission line applications and theory in more detail. ECE 447 is another hands on lab course. ECE 453 is also a lab course, but with a substantial lecture section that covers a wide array of topics related to radio systems (modulation, impedance matching, stability, non-linearity, S-parameters, etc). Professor Schutt-Aine also teaches a graduate class, ECE 546, on advanced signal integrity every couple of years that goes more in-depth on these topics.