EEE 498: Introduction to RF and Wireless Radio Design

Prerequisites: EEE 335 and EEE 241. Basic knowledge in linear systems, analog/digital circuits, and basic communication theory.

Textbook: Wireless Receiver Design for Digital Communications, 2nd Edition, Kevin McClaning.

Reference Textbook (not required): RF Microelectronics 2nd Edition, Behzad Razavi

Catalog Course Description: Radio Frequency (RF) Electronics is a specialization of electrical engineering that focuses on electronic systems and circuits operating in the RF electromagnetic spectrum. These systems most commonly include wireless devices, which exist "everywhere" in modern electronics. RF wireless hardware (e.g. transceivers) exist in most handheld electronics (smart phones, watches), computers, IoT devices, satellite communications, space vehicles, etc. Whether building electronics to explore the unknowns of deep space, working on the next generation of computer hardware, or designing our 5G communications networks, RF electronic hardware is key to each application's success. Due to the proliferation of wireless devices in society, almost every mid-to-large scale semiconductor company contains an RF division. Therefore, an engineer who has familiarity with RF may more quickly advance technology, is more valuable to corporations, and may apply RF techniques to innovate in other fields of electronics (e.g. high speed digital).

This course shall cover the basics of RF terminology, RF system-level definitions, RF performance requirements, and introduce wireless radio design.

The course will provide the students with the tools and techniques needed to:

- Learn and apply RF terminology such as dB, dBm, VSWR, return loss, mismatch loss
- Understand the basics of transmission lines, s-parameters, and impedance matching
- Understand propagation losses and link budgets.
- Understand, calculate, and assess performance impacts of system parameters such as: noise figure, sensitivity, P1dB, IP2, IP3, EVM, and phase noise.
- Analyze the trade-offs between radio architectures, sub-component performance, and overall system performance.

Course Topics:

- Receiver and Transmitter Architectures
- Quick lesson on transmission line theory, scattering parameters (s-parameters)
- Circuit Noise
- Introduction to Mixers, LNAs, and Oscillators
- Digital Modulation Schemes (QAM, QPSK, etc.)
- Gain Compression, Harmonic Distortion (HD), Intermodulation (IMD)

- Hardware Efficiency, Constellations, EVM, ACPR

Lab Projects:
The lab design projects will cover RF system simulation exercises using the Keysight ADS (Advanced Design System) software environment. Students will need to install the software on their PC and a license key will be provided.