ECE 592-105
Special Topics: Wireless Communication Systems

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Objective or Description: This course explores wireless communication through the lens of digital signal processing. Using this approach, the transmitted signals, channels, and received signals are all viewed equivalently as discrete-time sequences, thanks to Nyquist's theorem. The course utilizes an innovative experimental approach, employing the USRP (universal software radio peripheral) for software-defined radio programming, to make important connections between the theory of wireless digital communication and its realization to practice. The focus is the iterative design, implementation, and evaluation of a digital wireless communication link, with both lecture and laboratory components. By the end of the course, students will have built their own wireless communication link and have gained an understanding of design challenges, synchronization, equalization methods, channel estimation, and key physical layer features of IEEE 802.11 and 5G cellular physical layers. You must be signed up for both the lecture and laboratory sessions.

Prerequisites: An understanding of digital signal processing as obtained for example from EE 513 Digital Signal Processing and of digital communication, from a course like ECE 515 Digital Communication. Knowledge of and comfort with random processes (ECE 514 or equivalent) is essential to understand the stochastic aspects of communication systems. Familiarity with linear algebra and working with matrices will be useful. All programming will be in MATLAB.

Textbook:

- R. W. Heath Jr, *Introduction to Wireless Digital Communication: A Signal Processing Perspective*, Pearson, First Edition, 2017.
- A draft laboratory manual being co-developed by Professors N. Gonzalez-Prelcic and R. W. Heath Jr. tenatitvely called *Wireless Digital Communication Using the USRP and MATLAB* will be used.

Topics: This course aims to cover the following topics:

- Fundamentals of signal processing for wireless digital communications
- Software defined radio and the USRP hardware
- Modulation, pulse shaping, matched filtering and detection
- Synchronization and channel estimation in narrowband channels
- Orthogonal frequency division multiplexing (OFDM) for wideband channels
- Channel estimation, common gain and phase estimation in OFDM systems
- Timing synchronization and frequency synchronization in OFDM systems
- Dealing with IQ gain and phase imbalance

Grading:

Weekly assignments	40%
Labs	30%
Final lab report	30%