ECE 595 Syllabus Software-Defined Radio

Spring 2009

Course Format

Lecture: Wednesdays 6 – 8:45 pm

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Course Description

The course covers all aspects of SDR technology. Specifically it includes an overview of modern wireless systems, transceiver architectures, baseband signal processing algorithms, analog-to-digital converters, analog front-end components, digital hardware architectures, software architectures, middleware and the Software Communications Architecture (SCA), cognitive devices and networks, standardization bodies, software-defined radio products and services.

The course will include a hardware project. Two students can work in a group on the hardware project.

It is designed for graduate students/advanced undergraduate students, engineers, and other professionals employed in wireless communication and mobile computing.

The course assumes background in communication systems, signal processing, digital and analog electronics, and software.

Credit Hours: (3)

Prerequisites:

1. Admitted graduate student in either an engineering or science degree program;
2. Undergraduate students must have completed or must be taking concurrently ECE 495 – Modern Communication Systems and ECE 436 Digital Signal Processing.

Textbook:

J. H. Reed, "Software Radio," Prentice-Hall, 2002.
M. Cummings and T. Cooklev, "Software-Defined Radio Technology," 2009, (to be published); handouts.

Evaluation:

1. Matlab assignments and homework: 25%
2. Hardware project and report: 25 %
3. Mid-term: 20 %
4. Final exam: 30%

Course Outline:

1. Introduction to software radio concepts

2. Modern wireless systems
    a. Wireless channels
    b. Modulation techniques, OFDM
    c. Multiple-access techniques
    d. Wireless networks – Cellular, WLAN, WPAN, WMAN

3. SDR Architectures
    a. Basic architecture
    b. Software techniques: from spaghetti code to object-oriented design
    c. Middleware
    d. Software Communications Architecture

4. Baseband digital hardware
    a. Low-speed signal processing hardware: DSP. DSP architectures;
    b. Advanced DSP architectures
    c. C programming and DSP compilers
    d. High-speed digital signal processing hardware: FPGA, ASIC
    e. Multiprocessors

5. Algorithms
    a. Sampling rate conversion, decimation, and interpolation
    b. Receive diversity
    c. Transmit diversity and space-time coding
    d. Beamforming algorithms and architectures
    e. MIMO systems; MIMO OFDM

6. Transceiver architectures
    a. Superheterodyne
    b. Direct-conversion (zero-IF)
    c. Digital IF architecture
    d. Direct digital synthesis (DDS)
    e. Sampling architectures
    f. Multi-band and multi-mode architectures
    g. Current standardization work on new interfaces within transceivers

7. Analog to digital and digital to analog conversion
    a. Parameters
    b. Architectures

8. Analog front-end
    a. Diplexer (switchplexer, roofing filter)
    b. LNA
    c. PA and amplifier linearization methods
    d. Antennas
    e. Impedance matching
    f. Microelectromechanical systems (MEMS) and nanoelectromechanical systems (NEMS)

9. Cognitive networking
    a. Over-the-air software download
    b. Security in software radios
    c. Cognitive networking use cases and the need for a metalanguage
    d. Reconfigurable networking and current research on networking description language

10. Current industry trends
    a. Standardization bodies
    b. Government regulations
    c. Products and services involving SDR technology, case studies
    d. Likely future directions

Course Outcomes

A student who successfully fulfills the course requirements will have demonstrated:

1. a knowledge of design considerations for software-defined radio technology and products (a, e, 1, 2)
2. knowledge of software development methods for embedded wireless systems (a, k, 1, 6)
3. knowledge of modern wireless systems and smart antenna algorithms (a, e, k, 1, 2, 6)
4. knowledge of digital hardware architectures and understanding of development methods (a, e, k, 1, 2, 6)
5. an understanding of middleware in SDR and the SCA (a, e, k, 1, 2, 6)
6. understanding of analog RF components (a, e, k, 1, 2, 6)
7. understanding of ADC and DAC technology (a, e, k, 1, 2, 6)
8. an awareness of current industry trends (a, k, 1, 6)

ABET category:	Engineering science:	3 credits or 100%
	Engineering design:	0 credits or 0%