Radio Electronics p3 2020

Welcome to the first lecture on Wednesday Jan 15, 13.15 in Electrum room 211.

Text book: RF Microelectronics, Behzad Razavi, Pearson 2nd edition (available via Kårbokhandeln on KTH campus)
Course material: Lecture slides, Lab PM and project handouts are available through Canvas.
Reference books:

- Madhow, U., “Fundamentals of Digital Communication”, Cambridge Press
- Rappaport, T.S., “Wireless Communications: Principles and Practice”, Prentice Hall
- R. Johnson, JR., W. A. Sethares, A. G.- Klein, "Software Receiver Design", Cambridge University Press 2011

Examination: 6 credits, Grades A-F based on combined results from two equal parts I and II. However, 50% of points on each part is required to pass.

Part I. Written exam on L1-8.

Part II. SDR- Software Defined Radio. Individual reports on each of six projects and a final report. Compulsory.

Lab 1, 2 1.5 credits. Grade P/F.

The first half of the course follows the textbook chapters 1-4 with two matching labs and a second half consisting of a project (this second part is a modernization of the course that earlier focused more on circuit building blocks while here it is digital control of them). The course provides an understanding of how modern radios are designed and function. A number of basic concepts are discussed that limit the radio performance such as noise and non-linearity leading to the radio dynamic range. Modulation techniques are discussed and architectures of receivers and transmitters and how to make design choices depending on desired performance. Wireless standards are discussed and transceiver examples are given. The first lab contain rf-measurements of radio building blocks using spectrum analysis while the second contains building a radio transmitter and a receiver of those blocks including transmitting content from transmitter to receiver.

While radios always have analog components, the inclusion of digital components has opened up for more and more digital control and added flexibility. This is illustrated in the second part of the course which uses a USRP (Universal Software Radio Peripheral) hardware platform to do SDR experiments. This part of the course is hands-on. It teaches students basic principles of how to develop and implement digital communication systems on software defined radio platforms by comprehensive integration of theory and practice. After finalizing the course the students will be able to:

- identify all relevant components of a digital transceiver chain and their relationship
- implement algorithms for common digital transceiver tasks
- identify performance and hardware demands of relevant digital transceiver components and assess the feasibility of their implementation in software through practical testing
- assess the performance of different algorithms in a digital communication system

Tentative schedule

L1	Historical background to Mobile communication Chapter 1 Introduction to rf and wireless technology

L2	Chapter 2 Basic concepts in rf design. Slides 4-24 (ISI in ch 3.3.1)
L3	Chapter 2 Basic concepts in rf design. Slides 4-24 (Not ch 2.6-2.8)
L4	Problems Chapter 2
L5	Chapter3 Communication concepts (selected parts of text book, use book as reference)
L6	Chapter 4 Transceiver Architectures Part I (selected parts of text book)
L7	Chapter 4 Transceiver architectures Part II Slides 8-15 (not ch. 4.2.5 and 4.4)
L8	Continued Ch 4 on Transmitters. Exercise Chapter 4
LAB 1	Basic concepts in rf design
LAB 2	Transceiver architectures
L9-10	Software Defined Radio*, Lectures. Random Number Generation and Sinusoidal Waveform Generation in Component-Oriented Design Tools
L11-12	SDR Project 1. SDR Platforms: Architecture - Flexibility and Limitations - Current Developments in Industry and Academia
L13-14	SDR Project 2. Development Environment for Digital Transceiver Design, incl. e.g. USRP Hardware for Practical Testing
L15-16	SDR Project 3. Modulation and Decoding: Line Codes - Quadrature Modulation - Matched Filtering - Hardware Design Issues - Error Rates and Mathematical Models - Pulse Shaping - Eye Diagram for Analysis
L17-18	SDR Project 4. Synchronization and Channel Estimation: the AWGN Channel - Symbol Timing Recovery - Energy Maximization Methods - Linear Equalization - Equalizer Parameter Calculation Techniques
L19-20	SDR Project 5. Frame Detection and Frequency Offset Correction: Correlation-Based Methods - Moose Algorithm - Use of Training Sequences - Combined Approaches
L21-22	SDR Project 6. Error Detection and Correction: Parity Codes - Checksums - Cyclic Codes - Correction (Repetition and Redundancy Coding)