Low Power Wireless ECE510 Spring 2010

For most of the first 100 years of radio, Radio Frequency (RF) waves have been used to cover long distances—either two-way communication between well-equipped transmit-receive stations or one way from large broadcast transmitters to simple receivers. During the latter part of the 20th century, “Last Mile” applications began to dominate, where the long distance link is provided by fiber optic cable and only the “last mile” uses radio to distribute information to mobile and portable devices. In the 21st century, wireless links are commonly used between devices only a few meters apart—literally to replace wires. Low power wireless telemetry is also used in breakthrough applications such as the Smart Power Grid and monitoring of Ocean Wave and Wind Power Generators.

This course starts with a review of the fundamentals of low-power wireless propagation: electromagnetic; optical; and acoustic. The fundamentals are applied to a set of problems using familiar low-power wireless systems such as Bluetooth, point-to-point microwave, cellular handset, deep space communications, and ionospheric reflections. The next topic is the electronic circuitry needed for low power wireless communication, with a particular focus on the RF components that connect highly integrated CMOS mixed-signal devices to space. The final weeks of the quarter are devoted to the design of practical low-power wireless transmitters, receivers, and antennas to address the needs of several practical applications. The design projects are defined during the early weeks of the quarter, based on interests and needs of students in the class.

ECE510 Low Power Wireless is taught as a graduate class appropriate for students and industry professionals with a B.S. in a math-based science or engineering discipline. Familiarity with RF, RFIC, Mixed-Signal or Digital IC design is useful for the electronics, and an undergraduate course in electromagnetics is assumed. Students with diverse backgrounds are expected.

Grading is based on two in-class exercises and individual contributions to the class design project.

Course Outcomes: After taking this course, students will be able to write specifications and sketch designs for working low-power wireless circuits, systems and antennas. Students will calculate signal and noise levels from the output a CMOS IC through the RF transmit electronics and antenna through space into the receive antenna and through the small-signal circuitry to the CMOS baseband processing input. Individual students will focus on less-than 1 watt transmit power amplifiers, near-zero IF receivers, passive RF networks and simple antennas. For the class project, students will make individual contributions to the low power wireless design team.

Low Power Wireless is taught by Rick Campbell, whose low power radio designs have been used for everything from telemetry inside a research Corvette engine to the Search for Extra Terrestrial Intelligence (SETI) and moose tracking. His RFIC designs are found in more than 300 million cell-phone handsets. Rick is a founding member and past chair of the IEEE Microwave Theory and Techniques Society HF-VHF-UHF Technical Committee, and has been honored with many teaching, design, and technical writing awards.