Special Topics: Wireless Without Batteries
ECE 8813 – Spring 2017

Class Description:

Course	Title	Cr Hrs	Instructor	Days	Time	Location
ECE-8813	Special Topics: Wireless Without Batteries	3	Greg Durgin	MW	1 pm	Shenzhen

ECE 8813 Wireless Without Batteries
This class provides a comprehensive overview of "Wireless Without Batteries" – the emerging field of low-powered, energy-harvesting radio communications for telemetry, location, and identification. The course presents a multi-disciplinary treatment that involves antennas, propagation, communication theory, RF engineering, analog devices, and nanotechnology. Case studies in cutting-edge remote sensing, RFID, telemetry, and other fields are explored to illuminate concepts.

Instructor: Gregory D. Durgin 507 Van Leer
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Class Web Page: T-square

Textbook: Course notes and relevant papers will be posted online.

Prerequisites: No formal prerequisites. Suggested prerequisites are graduate standing and some background in undergraduate electromagnetics and communications theory.

Grading:

20% Homework – Expect approximately 4-5 homework assignments over the course of the semester.

40% Midterm Quizzes (2) – There will be 2 quizzes during the semester.

40% Final Project – A final project will be assigned and collected towards the end of the course. The last week of the course will be reserved for student project presentations.

Computer Usage: The web will be used extensively in this class to disseminate homework assignments, lecture materials, and class announcements. Some assignments may involve the use of Matlab™ or equivalent computational software. Most students should have access to this software through a university computer lab or their own personal computing packages. If not, please inform the instructor.

Tentative Lecture Topics:

I. **Basic Radiation Theory** – review of antenna theory and wave propagation; basic circuit modeling of antennas in transmit, receive, backscatter modes;

wire and aperture antennas; antennas on dielectric objects and metal; piezeoelectric materials; surface acoustic wave (SAW) devices. Case Study: SAW temperature sensor.

II. **Propagation Theory** – Backscatter link budgets; small-scale fading; double fading distributions; multi-antenna systems for backscatter radio. Case Study: UHF EPC Global RFID tags.

III. **RF Energy Harvesting** – Survey of energy-harvesting; battery fundamentals; review of time-harmonic transmission line theory; rectenna theory and design; charge pump theory and design; power optimized waveforms and multisine; RF scavenging; energy-banking systems; super-capacitors. Case Study: Intel WISP platform.

IV. **Communications Theory** – Rules for unlicensed spectrum operation; review of AWGN detection; orange noise model for RF readers; matched filter detection in colored noise; binary offset carrier modulation; spread-spectrum systems. Computational platforms for low-energy communications. Case Study: Power Line Sensor.

V. **Magnetic and Inductive Systems** – Biot-Savart modeling of cols and loops; circuit modeling of inductively-coupled systems; flux circuit model; classical magnetic materials (diamagnetism, paramagnetism); quantum effect magnetic materials (ferrimagnetism, ferromagnetism, super-paramagnetism); inductive RFID systems; Case Study: magnetostrictive electronic article surveillance (EAS). Case Study: MIT inductive resonant transfer.

VI. **Wireless Power Transfer** – Power exchange between large apertures; high-powered microwave sources; Case Study: Space Solar Power.

Honor Code: The Honor Code applies to every aspect of this class, with only one noteworthy exception: student discussion of concepts and techniques for solving homework problems is permitted and even encouraged outside the classroom. However, *all submitted work must be original*.