EE 4735
Embedded Systems Engineering

Curricular Designation: EE: elective CpE: elective

Catalog Description: EE 4735 – Embedded Systems Engineering: Covers the use of low-power microcontrollers in embedded sensing and control systems. Topics include: hardware-dependent C programming, commercial I/O devices, configuring I/O ports to interface with analog and digital sensors, actuators, transmitters, receivers, mobile robots, and wireless sensor nets. Credits: 3.0 Lec-Rec-Lab: (2-0-3) Semesters Offered: Spring, Summer
Restrictions: May not be enrolled in one of the following Level(s): Graduate
Pre-Requisite(s): (CS 1111 or CS 1142 or EE 2241) and (EE 3170 or EE 3171 or EE 3173)

Textbooks(s) and/or Other Required Materials:
3. Datasheets & Manuals for commercial hardware devices & software tools used in the course.

Prerequisites by Topic:
1. Familiarity with programming in C, in an embedded systems context.
2. Familiarity with microcontroller architectures and operation.
3. Familiarity with industry standard embedded I/O ports (e.g. GPIO, SPI, I2C, UART).
4. Familiarity with basic electronic circuitry & devices.

Course Objectives:
1. Mastery and practice of the interfacing techniques for connecting microcontrollers to sensors and actuators (both digital and analog).
2. Familiarity with the different considerations and constraints that embedded systems developers must deal with.
3. Mastery of a complete set of tools for embedded systems programming and debugging.
4. Familiarity & practice using a variety of commercial I/O devices (e.g. active & passive IR, ultrasonic, accelerometers, servo motors, mobile robot controllers, & wireless transceivers).
5. Familiarity and practice with those elements of wireless protocols relevant to embedded systems.
6. Ability to integrate the above, as demonstrated by a final team project that produces a working prototype.

Topics Covered:
1. Introduction to MSP430 microcontroller, eZ430-RF2500 card, & IAR Workbench suite.
2. Embedded C Programming in the context of the MSP430 architecture.
3. MSP430 configuration details, incl: clock generation & distribution, GPIO port configuration, IRQ handling, Low Power Modes, Timers (Capture & PWM), ADC, SPI, I2C, & UART Ports.
4. External sensors & actuators, incl: active & passive IR, ultrasonic, accelerometers, DACs, servo motors, mobile robot controllers, & wireless transceivers.
5. Wireless Comm: PHY Layer principles & practice employing the cc2500 Transceiver chip.
6. Wireless Comm: MAC Layer principles, applications, & pitfalls for embedded systems:
   (a) Case Study - IEEE 802.15.4 & Zigbee,
   (b) Case Study - IEEE 802.11 (WiFi).
7. Procedures & Specifications for Final Team Projects that demonstrate the ability to work as a team, apply the knowledge acquired, produce a working prototype, and write a final report.

### Relationship of the Course Content to Program Outcomes:

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<th>Outcome</th>
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### Contribution of Course to Meeting Degree Requirements:

3 Credit Hours – Engineering Topics

### Class/Laboratory Schedule (note: 1 hour = 50 minutes):

Lecture: 27 hours = 2 hours/week for 13.5 weeks
Laboratory: 36 hours = 3 hours/week for 12 weeks

### Prepared by:

Roger M. Kieckhafer, Associate Professor, May 26, 2017