

Sensor Networks and Embedded Systems

Enrollment & Prerequisites

A key prerequisite for this course is ES 1036 - (Programming Fundamentals for Engineers), or CS 3307 -(Object-Oriented Design and Analysis), or ECE4470 - (Microcomputer Engineering) , which may be waived only for Ph.D. students or after passing a test in C Language. The course is meant for Ph.D., M.Sc., and M.Eng. students with a high-level of analytical ability, self-motivation and a high interest in research and development.

Course Objectives

This course is meant to be a theory with hands-on type course, giving students a chance to deal with embedded system topics, and then use those concepts to work on various applications such as Wireless Sensor Networks (WSN) as well as Programmable Logic Controllers (PLC) by developing and debugging embedded system hardware and firmware. This course also aims to train students in the craft of academic research, student participation in active discussions of the course topics through research papers will be expected. In lab sessions, students will gain hands-on design experience through the use of the state-of-art commercial design tools.

After completing this course, student should be able to:

- Handle issues such as embedded processor selection, hardware/firmware partitioning, development tools, firmware architecture, firmware design, and firmware debugging,
- Use of sensor networks, and propose, implement, and evaluate new ideas for solving sensor network design issues,
- Work on applications of wireless sensor networks, describe the concepts, protocols, and differences underlying the design, implementation,
- Describe major components in a PLC and their functional operation.
- Write a basic PLC program implementing sensor and relay technology in a circuit

Course Readings

- The required book for the course is: *Industrial Wireless Sensor Networks: Applications, Protocols, and Standards*, V. Çağrı Güngör, Gerhard P. Hancke, CRC Press, 2013.
- Recommended book: *Networking Wireless Sensors*, Bhaskar Krishnamachari, Cambridge University Press, 2005.
- Programmable Logic Controllers, 4th ed. Frank D. Petruzella (2011), McGraw Hill. ISBN # 0-07-351088-0
- Beyond these, we will also read and discuss more recent papers from the literature.

Course Outline

The following is an outline for the course, describing the topics we will be covering through the lectures in this course:

1. Applications of Industrial WSNs
2. Embedded Microprocessor Systems
3. Design Challenges and Objectives in Industrial WSNs
4. Reliable and Robust Communications in Industrial WSN
5. Network Security in Industrial WSN
6. Industrial WSN Standards
7. Overview of PLC logic and relays
8. Process control

Research Project

Besides the weekly lectures, critiques, and discussion, a large component of the course will be a substantial research project on sensor networks. Details on this will be provided during the semester. The projects will be graded on the basis of team success as well as individual effort, regular progress updates, the mid-term and final project reports, and final project presentations.

Grading Policy

In this advanced Graduate-level course, it is expected that all students will be motivated, responsible for their own learning, and participate actively. Each student must present and participate actively in the discussions each week in class, complete all assignments in a timely manner (reading assignments may be tested using quizzes), and contribute significantly to the group research project.

The course grading policy is accordingly as follows:

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| Assignments | 10% |
| Mid-term | 10% |
| Final | 30% |
| Lab | 50% |

Late Assignments: 15% penalty/day.

Course Description:

Lab Assignment Overview:

- Lab #1: Basics of Microprocessor - AVR and IAR Embedded Workbench .
- Lab #2: Decode logic, EPROM, basic user I/O, timer ISRs and assembly.
- Lab #3: SRAM, RS-232, monitor/debugger, assembly.
- Lab #4: EEPROM, LCD, and C programming.
- Final Project/Lab #5: Student's choice.