ECE5620 Syllabus, Fall-2011

No: ECE 5620

Title: Embedded System Design. Cr. 4 (LCT: 4)

WSU Catalog Description:
Prereq: ECE 4600 or consent of instructor. Study of a modern microcontroller architecture and its subsystems. Wired and wireless protocols for vehicular networking applications. Design and implementation of real-time embedded systems. (F,S)

Coordinator: Syed Masud Mahmud, Associate Professor of Electrical and Computer Engineering.

Instructor: Syed Masud Mahmud, Associate Professor of Electrical and Computer Engineering.
Office Hours: MW 1:00pm – 3:00pm
Office Location: 3138 Engineering Building
Phone: 313-577-3855, Fax: 313-578-5845
Email: smahmud@eng.wayne.edu
Web Page: http://ece.eng.wayne.edu/~smahmud/mypage.htm
Course Meeting Time: MW 3:30 – 5:20pm
Course Meeting Location: 1129 MAIN

Goals: The goals of this course are to become familiar with the architecture and instruction sets of different microprocessors, to design various types of real-time systems using the latest microcontrollers, to learn protocols for wired and wireless networks, to learn techniques of teamwork and product design, and to prepare students for better job opportunities in the area of embedded systems.

Learning Objectives: After completing this course, students should be able to do the following:
1. Design and implement software that utilizes interrupts.
2. Develop software to collect data from various types of sensors.
3. Explain real-time issues and task switching including latency such as simultaneously controlling/flashing a number of LEDs and other types of output devices.
4. Design products using microcontrollers and various analog and digital ICs.

Textbook: Lecture Notes by Syed M. Mahmud (Get your lecture notes from HERE)

Reference Texts: Manuals from Microchip, Bluetooth, Lin and Flexray

Prerequisites by Topic: (ECE4600) Digital logic, assembly language, parallel and serial I/O.

Corequisites by Topic: none

Topics:

1. PIC 18 Family Microcontroller (4 Lectures)
   - Architecture and Instruction Set
   - Various Subsystems of PIC Microcontroller
   - Development System and MPLAB

2. CAN: Controller Area Network (2 Lectures)
   - Basic Concepts & Definitions
• Identifiers & Arbitration
• Robustness & Flexibility
• Message Formats
• Errors at Message and Bit Level

3. Time Triggered CAN (1 Lecture)

4. LIN Protocol (1 Lecture)
• LIN Architecture
• Message Format (Get your free copy of LIN Manual from http://www.lin-subbus.org)

5. Bluetooth Protocol (3 Lectures)
• Piconets
• Inquiry and Paging Techniques
• States of a Bluetooth Device
• Message Format

6. Flexray Protocol (2 Lecture)
• Flexray Architecture

7. CANoe Software (2 Lecture)
8. Wi-Fi DSRC Protocol (1 Lecture)

Course Structure: The class is divided into a number of groups and each group contains 2 to 3 students. During the first half of the semester, the students attend lectures and work on three design assignments. During the second half of the semester, the students work on a major design project.

Computer Resources: Windows XP PC

Laboratory Resources: A laboratory containing 9 PCs, several high-end multimeters, function generators and oscilloscopes is available for the students.

Laboratory Policy: There is absolutely no smoking: eating or drinking in any ECE instructional lab. These labs must be kept neat and each student is responsible for insuring that the equipment on his/her workbench is neatly arranged, that all the leads and other equipment are put away, and that there are no scraps of paper or other garbage left on or near his/her work station. Coats, briefcases: Knapsacks and other personal belongings are not permitted on or near the benches. These items must be kept on the coat rack near the door, not on the benches, window sills or the floor near the benches. The door to the lab must be kept locked at all times; unlocking or propping open the door at any time is expressly forbidden. Guests are not permitted in the lab at any time, and no one but the instructor may open the door to admit anyone after the class has begun.

Project Report: The project report must contain the following items in the same order as shown below.

1. Abstract (5 Points)
2. Introduction (9 Points)
3. Background materials (14 Points)
4. Detailed description of your work including design with detailed schematic diagram (25 Points)
5. Analysis, results and discussions of your work (15 Points)
6. Conclusions (5 Points)
7. References (2 Points)
8. Appendix (25 Points)
   i. Executive summary. (3 Points)
   ii. Design alternatives considered. (3 Points)
   iii. Operating procedure of your product (explain how to use the product). (3 Points)
iv Constraints due to OSHA, FCC, EPA and other regulations. (3 Points)
v Parts list. (2 Points)
vi Cost analysis. (2 Points)
vii Description of the problems occurred during the design process and how the problems were solved. (2 Points)
viii Distribution of work among different partners of a group, and the contribution of each partner in percent. (2 Points)
ix Program Listing (well documented assembly code). (3 Points)
x Data sheets of the components used. (2 Points)

Oral Presentation: Your oral presentation will be graded based on the following items.
1. A title slide containing the title of the project, name of the team members, group number, year and semester.
2. A slide containing the outline of the talk.
4. Technical contents of the slides.
5. Eye contact with the audience.
6. Loudness of speaker’s voice.
7. Speaker’s confidence.
8. Speaker’s body motion.
9. Reading slides versus talking to the audience.
10. Handling of questions.

Distribution of Points:

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<tr>
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<th>Percentage</th>
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<tbody>
<tr>
<td>Midterm Exam</td>
<td>40%</td>
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<tr>
<td>Homework</td>
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<tr>
<td>Working prototype</td>
<td>27%</td>
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<td>Professional looking prototype</td>
<td>3%</td>
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<tr>
<td>Ten-Minute Oral Presentation by Each Student (all students must attend presentations)</td>
<td>8%</td>
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<tr>
<td>Report</td>
<td>14%</td>
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Some extra credits will be given for submitting Professional Quality Video Clips of Good Working Prototypes.

Grading Scale: Percentage Grade (Honor Point Value)

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<th>Score Range</th>
<th>Grade</th>
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<td>90-94</td>
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<td>85-89</td>
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Attendance: Every student is expected to attend all lectures. All students must also attend their regular group meetings.

Schedule:
- Late Registration, Late Adds: Aug 31 - Sep 7, 2011
- Last Day to Withdraw: Nov 12, 2011
- Midterm Exam: Oct 24, 2011
- Oral Presentations: Dec 14, 2011
- Project Report Due (Both Hard and Soft copies): Dec 14, 2011

Makeup Exam and Makeup Assignment Policy:
- All assignments must be submitted on time. No late submission will be accepted unless the student notifies the instructor ahead of time showing some valid reasons (such as town of out business trip, sickness, etc.) for not being able to submit the assignment on time. The student must present valid official documents to defend his/her cases.
- All students must take the midterm on the scheduled date. If a student thinks that he/she can't take the midterm on the scheduled date due to some unavoidable circumstances, such as out of town business trip, sickness, etc., then he/she must notify the instructor before the scheduled exam time. In that case the instructor may give a makeup exam to the student. However, the student must present valid official documents to defend his/her case.

Outcome Coverage:
(a) An ability to apply math, science and engineering knowledge. The assignments, midterm exam and project require direct application of mathematical, scientific, and engineering knowledge to successfully complete the course. This requires performing various digital and analog circuit analysis methods in a formal manner and many supporting and follow-up calculations.

(b) An ability to design and conduct experiments, as well as to analyze and interpret data. A major focus of the course is to teach students microcontroller based real-time embedded systems. For the course assignments, students design and test various systems relating to data manipulation, interaction with external devices via parallel I/O lines, precise timing measurements, and collection of data from external devices via analog to digital converter. Students conduct experiments using microcontrollers and off-the-shelf analog and digital integrated chips.

(c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability. Students work in teams of three students. The assignments involve the design of various real-time embedded systems which is constrained by the type of processor, the clock frequency of the processor, number of digital I/O pins, number of analog channels, the size of analog-to-digital converter and the amount RAM and ROM available within the system. Memory saving and execution time are practical constraints that must be met in designing assembly code for critical applications in automotive control and other application area. Students go through several iterations of refining and debugging their initial code before they are able to arrive at working designs (programs). The students are required to work on a major design project to make a product. The students make their product in compliance to the laws and constraints imposed by the federal and local regulating agencies such as FCC, OSHA and EPA.

(d) An ability to function on multi-disciplinary teams: Students work or their design assignments and projects in teams of three students. The project work involves the design of electronic controllers, automated vehicles, voice activated devices and many other types of systems that are of multi-disciplinary types. Organization and active contribution to team effort is required in the course.

(e) Identify, formulate and solve engineering problems. The students achieve this item as they analyze
given problem, write a working assembly program and construct a working hardware to solve the problem. Students learn to formulate their understanding of a given problem in the form of a logical sequence of process blocks (flowcharts). They then translate such flowcharts into assembly programs and hardware modules for generating precise solutions.

(g) an ability to communicate effectively: All students are required to make an oral presentation on their project work. The students are also required to submit a well-written technical report on their project work. The oral presentation and technical report writing process help them in achieving effective communication skills.

(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice: Students learn to use the MPLAB software, a modern tool developed by Microchip. Students also use the latest state-of-the-art sensors, actuators, analog and digital integrated chips, and other components for the assignments and project work.

Cheating Policy and Penalty for Cheating: Cheating is defined by the University as “intentionally using or attempting to use, or intentionally providing or attempting to provide, unauthorized materials, information, or assistance in any academic exercise.” This includes any group efforts on assignments or exams unless specifically approved by the professor for that assignment or exam. Evidence of fabrication or plagiarism, as defined by the University in its brochure “Academic Integrity,” will also result in downgrading for the course. Students who cheat on any assignment or during any examination will be assigned a failing grade for the course.

Accommodations for Students with Disabilities: If you have a documented disability that requires accommodations, you will need to register with Student Disability Services for coordination of your academic accommodations. The Student Disability Services (SDS) office is located at 1600 David Adamany Undergraduate Library in the Student Academic Success Services department. SDS telephone number is 313-577-1851 or 313-577-3365 (TDD only). Once you have your accommodations in place, I will be glad to meet with you privately during my office hours to discuss your special needs. Student Disability Services’ mission is to assist the university in creating an accessible community where students with disabilities have an equal opportunity to fully participate in their educational experience at Wayne State University.

Please refer to the SDS website for further information about students with disabilities and the services we provide for faculty and students: http://studentdisability.wayne.edu/

Prepared By: Syed Masud Mahmud, Associate Professor of Electrical and Computer Engineering

Last Revised: August 31, 2011