CS 738 – Embedded Systems Programming (3) – Spring 2016 (lv2)

Class Room/Hours: 261 Jabara Hall; Tue/Thu 11:00 AM to 12:15 PM (Jan. 19 – May 13)
Lab Room/Hours: Classroom and CAPPLab (in JB245)

Instructor: A S MD Asaduzzaman (Dr. Zaman)
Office Room: 253 Jabara Hall
E-mail: Abu.Asaduzzaman@wichita.edu
Phone: 1-316-978-5261 (Office); 1-561-843-2231 (Mobile)

Office Hours: Tue & Thu 12:15 p.m. to 1:45 p.m.
Or, by appointment (via e-mail/phone)

Do not hesitate to see me in my office during my office hours if you want to discuss any problems. For most questions concerning clarification of materials covered in class, e-mail is the preferred mode of communication. I will respond promptly to these queries. You must use your WSU e-mail account. Keep your WSU e-mail account current and below quota. Please note that your e-mail may get lost.

Catalog Description (proposed): CS 738. Embedded Systems Programming (3). Studies the requirements and design of embedded software systems. Application of the C programming language in the implementation of embedded systems emphasizing real-time operating systems, interfacing to assembly and high-level languages, control of external devices, task control and interrupt processing. Prerequisite: CS 594.

Class Attendance: It is very important that you attend each and every class and come on time. If you are late (or absent) without any acceptable reason for more than 10% classes, up to 10% marks should be deducted from your final grade.

Pre-Requisite: The pre-requisite for this course is CS 594/594L (or equivalent). Students who enroll in this class are expected to have a good understanding of microprocessor architectures and adequate knowledge in Assembly/C programming languages. By continued enrollment in this class, you are certifying that you have met the pre-requisite.

Course Objective: The objective of this course is to study the design and programming of hardware/software embedded systems using Assembly/C/C++ languages. Special attention is given to application oriented programming and research oriented team-project activities. The outcomes of this course include: (i) Students learn to apply knowledge of programming embedded systems using Assembly/C/C++, emphasizing control of tasks/devices, process interrupts, interfacing to assembly and high-level languages, etc. (ii) Students recognize the need for and an ability to engage in continuing professional development. And, (iii) students learn how to use current knowledge and skills necessary for future embedded systems.

Text-Book: Class Notes/Handouts (see WSU Blackboard)
Topics Include:
Embedded Systems: Introduction
   a) Overview: Hardware / Software
   b) DEMOEM and Dragon12plus boards / CodeWarrior Tool
Programming Embedded Systems
   a) Lab 1 – Programming Sensors
   b) Lab 2 – Programming Motors
   c) Lab 3 – Programming Timers
   d) Lab 4 – Programming Interfaces
   e) Lab 5 – State Machine and Concurrent Processing
   f) Embedded Coding (Inline Assembly in C/C++)
Embedded Systems Design
   a) Design Factors and Performance Issues
   b) Single- and General-Purpose Processors: Software, Peripherals, etc.
   c) Cache Memory Subsystems to Improve Performance to Power Ratio
Embedded Systems Research
   a) High-Performance/Cloud Computing (in Embedded Systems)
   b) Low-Power Computing (for Embedded Systems)
   c) Real-Time Supports (for Embedded Systems)
   d) Hardware-Based Security (for Embedded Systems)
   e) Embedded Devices/Applications
   f) Selected Related Published Articles

Online/Blackboard: All announcements and instructional material for this course will be made available on WSU Blackboard (URL: http://blackboard.wichita.edu). It is expected that you will regularly check the Blackboard (Bb) webpage, download files as necessary, and keep your WSU email account current and below quota. CS 738 course should have the following folders:
  - CS738Home > (Landing page) Announcements
  - Information > Syllabus, Schedule, etc.
  - Content > Class_Notes_PPT (PowerPoint files), Handouts (PDF files)
  - Tests > Homework (HW), Quizzes, and Exams
  - Labs > Lab/Programming assignments
  - Projects > Project information
  - Discussions > Course related issues (optional)
  - Tools > My Grades, Send Email, etc.

Class Notes: Class notes should be available on course webpage via WSU Bb as they are to be covered in a class. There may be some blank areas in these notes, which you should fill in the class. The class notes should be considered as supplements to the textbook materials, not a replacement of it. The purpose of providing these class notes is to give you the opportunity to focus on lecture and class discussion, without diverting your attention to writing notes. It is expected that before coming to class, you should read the relevant materials and previous class notes. This should improve your understanding of the materials and clarify the concepts that remained unclear after reading the book/materials and the notes. Class notes alone will not make up for missing classes or inattention in class. Note: Class notes may include copyrighted material from various sources. These are for your own use and they should not be copied or distributed by any means or to be used by anyone else.
Grading Policy (Tentative):
NOTE: Same grading scale for both undergraduate and graduate students.

<table>
<thead>
<tr>
<th>Type</th>
<th>Points</th>
<th>Remarks</th>
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<tbody>
<tr>
<td>HW (5) + PERF</td>
<td>(10+5)%</td>
<td>HW-01 due on the 2nd week</td>
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<tr>
<td>Quiz/Lab (5)</td>
<td>10%</td>
<td>Quiz-1/Lab-1 is on the 3rd week (Thu)</td>
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<td>Quiz 15-30 minutes, closed book; then Lab</td>
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<td>Exam</td>
<td>20%</td>
<td>Before the Mid-Term point (TBD);</td>
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<td>70 minutes, closed book (one 8.5x11 inches note-sheet)</td>
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<td>Cumulative Exam-2</td>
<td>25%</td>
<td>Before he semester ends (TBD);</td>
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<td>70 minutes, closed book (one 8.5x11 inches note-sheet)</td>
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<tr>
<td>Literature Survey and Proposal</td>
<td>7%</td>
<td>6+ pages (survey report); Word, 1-inch margins, single-spaced text, 12-pt times new roman font; template; 1+ page (proposal); due after the Mid-Term point</td>
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<tr>
<td>Demo/Oral Presentations</td>
<td>8%</td>
<td>15-30 min; PPT Slides (template); Classroom or open-house; Softcopy due by the Study Day;</td>
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<td>Final Report</td>
<td>15%</td>
<td>15+ pages; Word, 1-inch margins, single-spaced text, 12-pt times new roman font, figures, tables, references; hardcopy and softcopy due date by the Study Day;</td>
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Project Grading: Proposal (7%) – One proposal/survey per group; peer-review by students;
Demo (8%) – Oral/Poster (PPT slides); (Students 4%, Instructor 4%);
Report (15%) – One hard/soft-copy report per group; Instructor;

Your final course grade will be approximately based on the following:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>A</td>
<td>93-100</td>
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<tr>
<td>A-</td>
<td>90-92</td>
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<tr>
<td>B+</td>
<td>87-89</td>
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<tr>
<td>B</td>
<td>83-86</td>
</tr>
<tr>
<td>B-</td>
<td>80-82</td>
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<tr>
<td>C+</td>
<td>77-79</td>
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<tr>
<td>C</td>
<td>73-75</td>
</tr>
<tr>
<td>C-</td>
<td>70-72</td>
</tr>
<tr>
<td>D+</td>
<td>67-69</td>
</tr>
<tr>
<td>D</td>
<td>63-65</td>
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<tr>
<td>D-</td>
<td>60-62</td>
</tr>
<tr>
<td>F</td>
<td>0-59</td>
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Total 93 out of 100 does not guaranty an ‘A’ grade, it depends on overall class performance.

Important Notes:
1. No e-mail submission. (Repeat) No e-mail submission.
   - Everyone must turn in his/her own assignment, unless special permission is given.
2. No late submission for assignments after a week from the actual due date/time.
   - Up to 70% points should be subtracted for any late submission.
3. No make-up exam.
   - Only exceptions: in case of an emergency and/or with prior consent.
4. NO late submission for project report.
   - One project report should be submitted by each group.
5. Professionalism (e.g., proper manners) is highly expected.
6. All academic dishonesty cases will be handled following the University Code of Academic Conduct. You may check the University Catalog for further information.

GTA Information:
Name: Kishore K. Chidella
E-mail: kkchidella@wichita.edu
Room/Hours: CAPPLab JB 245 Tue/Thu 12:30 – 1:30 p.m.
NOTE: GTA will grade (and answer your questions regarding) assignments and quizzes.
It is important to understand that the GTA should grade all assignments and quizzes. GTA should also answer any of your questions regarding assignments and quizzes grades. However, s/he is not allowed to solve any problem for you. If you have any questions regarding the course materials and/or assignments, you should immediately contact the course instructor.

**Laboratory Information:**
There are Lab Assignments and Projects that need programming; however, there is no Laboratory assigned for this course! We plan to use the Classroom as a Laboratory as needed. To do that we’ll provide the hardware (microprocessors, etc.); however, students should have their Laptop (at least one per group) loaded with CodeWarrior software. In addition, you are welcome to stop by Computer Architecture & Parallel Programming Laboratory (CAPPLab) in room 245 Jabara Hall (visit us online at URL: [http://www.cs.wichita.edu/~capplab/](http://www.cs.wichita.edu/~capplab/)). Objectives of CAPPLab includes: (i) Lead research in high-performance low-power computing and networking systems and related fields. And, (ii) Teach computer architecture, embedded systems, parallel/multicore programming, and related courses. Currently CAPPLab has the following resources: multicore Workstations/PCs, Linux/Windows, embedded systems, OpenMP, Open MPI, CUDA/GPGPU, SPEC, VisualSim, and supercomputer access.

**HW Assignments:** There should be about 5 take-home assignments and you should solve them individually. Assignments should be posted on Bb. After graded assignment is returned, the solution keys should be posted on Bb. You should submit your assignment solutions in person before the beginning of the lecture. Any late submission should be treated as mentioned in the Important Notes section. GTA should grade the HW assignments and you should see the GTA first if you have any questions regarding your grades. Total point from HW assignments towards the final grade is 10%. In addition, there will be 5% points for class performance/activities.

**Quizzes and Labs:** Total point from quizzes and labs towards the final grade is 15%.

**Quizzes:** There should be about 5 quizzes. For Quiz-1, Quiz-2, and Quiz-3, you should have approximately 15 minutes. But for Quiz-4 and Quiz-5, you should have approximately 30 minutes. If there is any remaining class time available after a quiz, there should be lecture or Lab session followed by the quiz. After graded quiz is returned, quiz solution keys should be posted on Bb. **There will be no make-up for quizzes.** Please note that all quizzes are closed-book. GTA should grade the quizzes and you should see the GTA if you have any questions regarding your grades. Total point from quizzes towards the final grade is 5%.

**Lab Assignments:** There should be 5 Lab assignments: Lab 1 – Programming Sensors, Lab 2 – Programming Motors, Lab 3 – Programming Timers, Lab 4 – Programming Interfaces, and Lab 5 – State Machine and Concurrent Processing. All assignments will need CodeWarrior and DEMOEM/Dragon12plus and should be solved as a group. Lab assignments should be graded in the Lab by the GTA. For grading purpose, each Lab should have two parts: demo and quiz. Maximum point from Lab assignments towards the final grade is 5%.

**Team-Project:** There should one final project for a group of students. Each group should consist of three students. Each project should be conducted by the assigned group. There may be some exceptions per instructor’s written consent. If a group has both undergraduate and graduate students, it should be considered as a graduate group for grading purposes. Each project should have three major components – project proposal, demo presentation, and written report. Maximum point from project towards the final grade is 30% (7 point from proposal/survey, 8
points from oral/demo presentation, and 15 points from 15+ pages written report). Each UG group should submit a 4+ pages proposal/survey; but each GR group should submit a 7+ pages proposal/survey. Each UG group should make a 10-12 minutes demo presentation; but each GR group should make a 15-20 minutes demo presentation using poster or PPT slides. Each UG group should submit a 10+ pages report; but each GR group should submit a 15+ pages report. Reports should be written using the provided template.

**Exams:** Three should be two Exams – Exam 1 should be right before the Mid-Term point and Exam 2 should be right before the semester ends. The exact dates should be announced in class and posted on Bb ahead of time. Exam 1 should be administered based on the material covered since the beginning of the semester. Exam 2 should be administered based on the material covered since Exam 1. There is no test on final exam week. There will be no make-up Exams. *All exams are closed book and closed notes.* However, you can have one hand-written 8.5x11 inches cheat-sheet (both-sided) for each Exam. Any absences from the Exams must be arranged with the instructor as soon as possible. Absences not so arranged will result in grades of zero. *Total point from Exams towards the final grade is 45% (20% from Exam 1 and 25% from Exam 2).*

**Additional Points (per Grading Issues):**
If you think your assignments or tests are graded unfairly, then you must send me an email explicitly articulating your rationale for additional points. You must email me within one week from when the assignment/test was returned (or the grades were available). Then you must bring the assignment/test to my office and I will render a decision. Do NOT expect to discuss it with me in my office without any prior arrangement.

**Medical Excuses and Family Emergencies:**
There are times in which a student must miss assignments and/or tests because of a medical situation or a family emergency. If any of these situations arises, then the student should discuss the matter at the earliest possible time with (1) his or her academic advisor, (2) a counseling dean, if appropriate, and (3) with the course instructors. You may need to properly document each situation. If the reason for missing a test is illness, a doctor’s note will be consent.

**Academic Honesty:**
You are expected to abide by WSU’s academic honesty policy (see Undergraduate Catalog or Graduate Bulletin for a description of this policy). The following excerpt from the policy is provided for your guidance:

> “Students who compromise the integrity of the classroom are subject to disciplinary action on the part of the University. Violations of classroom standard include:
> 1. Cheating in any form, whether in formal examinations or elsewhere
> 2. Plagiarism, using the work of others as your own without assigning proper credit to the source
> 3. Misrepresentation of any work done in the classroom or in preparation for class
> 4. Falsification, forgery, or alteration of any documents pertaining to academic records
> 5. Disruptive behavior in a course of study or abusiveness toward faculty or fellow students.”

**Incomplete (“I”) Grade:**
Like other grades, “I” is given at discretion of the course instructor. I will give an incomplete (“I”) grade only if you have been making satisfactory progress in a course except for work that
could not be completed due to circumstances beyond your control (such as illness, serious accident, death in family, natural disaster, etc.). You will be asked to produce evidence. If incomplete works due to these extraordinary events take place before the last date to withdraw, and cannot be completed before the end of the semester, then you should withdraw from the course. I will not give “I” for you to leave early for the semester break. An incomplete for a course must be removed by the end of the next semester or the “I” will change to “F.”

Disability Services:
If you have a physical, psychiatric/emotional, medical, or learning disability that may impact on your ability to carry out assigned course work, I would encourage you to contact the Office of Disability Services (DS). The office is located in Room 173 of Grace Wilkie Hall Annex, 316-978-3309 (voice, tty). DS will review your concerns and determine, with you, what accommodations are necessary and appropriate for you. All information and documentation of your disability is confidential and will not be released by DS without your written permission.

Definition and Assignment of Credit Hours:
According to the U.S. Department of Education a "credit hour" is a measure of graduate or undergraduate academic work represented in intended learning outcomes and verified by evidence of student achievement that reasonably approximates not less than one hour of classroom or direct faculty instruction and a minimum of two hours of out-of-class student work for each week of instructional time for approximately 15 weeks for one semester, or an equivalent amount of work over a different amount of time.

Success in this 3 credit hour course is based on the expectation that students will spend, for each unit of credit, a minimum of 45 hours over the length of the course (normally 3 hours per unit per week with 1 of the hours used for lecture) for instruction and preparation/studying or course related activities for a total of 135 hours.

Important Dates and Tentative Exam Schedule for
CS 738 Spring 2016 Term:

Classes begin: January 19 (Tue) ← Syllabus / K-Probe
First HW assignment due: January 28 (Thu)
Quiz-1/Lab-1: February 4 (Thu)
Quiz-2/Lab-2: February 11 (Thu)
20th Day Report cutoff: February 15 (Mon)
Quiz-3/Lab-3: February 18 (Thu)
Lab-4: February 25 (Thu)

Exam 1: March 3 (Thu)
Mid-term point: March 9 (Wed)
Lab-5: March 10 (Thu)
Spring Break begins: March 14 (Mon)
Spring Break ends: March 20 (Sun)
Project proposal due: March 24 (Thu) ← One 7+ pages hardcopy per group
Quiz-4: April 7 (Thu)
Quiz-5: April 21 (Thu)
Project oral/demo due: April 26 & April 28 (Tue & Thu) ← CR, softcopy

Exam 2: May 5 (Thu) ← Spring classes end
Project report due: May 6 (Fri) ← One 15+ pages hard/soft-copy
Tentative Course Plan

<table>
<thead>
<tr>
<th>Date ranges for each week of the semester</th>
<th>Remark</th>
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<tbody>
<tr>
<td>Week 1 (Eval-1) 1/19, 1/21</td>
<td>CS 738: Embedded Systems Programming; Course Syllabus; \textit{K-probe}; Embedded Systems; Programming; DEMOED board; CodeWarrior Tools; \textit{Team Project}; HW-1 (assign); HW Submission/Grading Policy;</td>
</tr>
<tr>
<td>Week 2 1/26, 1/28</td>
<td>H1 Review; \textit{Team Project: Topics, Grading, etc.; Reminder: Proposal due after Spring Break!} HW-1: Due on Thu; hardcopy, before beginning of the class; Reminder: QUIZ/LAB 1-3! (Next 3 weeks; 30 minutes; closed book; note-sheet okay);</td>
</tr>
<tr>
<td>Week 3 2/2, 2/4</td>
<td>Q1 Review; Lab-1: Programming Sensors; QUIZ-1/Lab-1 (30-minute quiz, 45-minute Lab, Thu);</td>
</tr>
<tr>
<td>Week 4 2/9, 2/11</td>
<td>Q2 Review; Lab-2: Programming Motors; QUIZ-2/Lab-2 (30-minute quiz, 45-minute Lab, Thu);</td>
</tr>
<tr>
<td>Week 5 2/16, 2/18</td>
<td>Q3 Review; Lab-3: Programming Timers; QUIZ-3/Lab-3 (30-minute quiz, 45-minute Lab, Thu);</td>
</tr>
<tr>
<td>Week 6 2/23, 2/25</td>
<td>H2 Review; Lab-4: Programming Interfaces; Reminder: EXAM-1 on Mar. 3! HW-2: Due on Thu; hardcopy, before beginning of the class; Lab-4 (45-minute), Thu;</td>
</tr>
<tr>
<td>Week 7 3/1, 3/3</td>
<td>Ex1 Overview: Exam-1; Due: P. Proposal (hardcopy, 7+ pages); discussions; Template on Bb; EXAM-1 (Thu, 70 minutes; Closed book; One 8.5x11 inches note-sheet is allowed);</td>
</tr>
<tr>
<td>Week 8 3/8, 3/10 Mid-term point</td>
<td>L5 Exam-1 return; Lab-5: State Machine and Concurrent Process Model; HW-3 (assign); Lab-5 (Programming Control Systems, 45-minute), Thu; Reminder: Project Proposal (due after Spring Break)! 7+ pages; Template on Bb;</td>
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<td>3/14 - 3/20 Spring Break!</td>
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<tr>
<td>Week 9 3/22, 3/24</td>
<td>H3 Embedded Systems Design: Introduction; HW-3: Thu; hardcopy, before the class; Project Proposal on Thu (no extension!);</td>
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<tr>
<td>Week 10 3/25, 3/31</td>
<td>H4 Review; Embedded Systems: Design Factors, Performance issues; HW-4 on Thu; hardcopy, before the beginning of the class; Reminder: Quiz-4 next week!</td>
</tr>
<tr>
<td>Week 11 4/5, 4/7</td>
<td>C4 Review; General-Purpose Processors: Software; QUIZ-4 (30-minute, Thu);</td>
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<tr>
<td>Week 12 4/12, 4/14</td>
<td>H5 Review; Standard Single Purpose Processors: Peripherals; HW-5 on Thu; hardcopy, before beginning of the class; Reminder: Quiz-5 next week!</td>
</tr>
<tr>
<td>Week 13 4/19, 4/21</td>
<td>C5 Review; Memory; Cache memory to improve performance to power ratio; QUIZ-5 (30-minute, Thu);</td>
</tr>
<tr>
<td>Week 14 4/26, 4/28</td>
<td>Project Demonstration: oral presentation – class/outside. 15/60 minutes per group; Project Report (15+ pages per group); Reminder: EXAM-2 on May 5!</td>
</tr>
<tr>
<td>Week 15 5/3, 5/5</td>
<td>Ex2 Overview: Exam-2 (Cumulative, Thu); Future of Embedded Systems; EXAM-2 (Thu, 70 minutes; Closed book; One 8.5x11 inches note-sheet is allowed); Project Report: Due by 5 PM on May 6; 15+ pages per group, hardcopy, Word file, Template and Information on Bb;</td>
</tr>
<tr>
<td>Final Week 5/7 - 5/13</td>
<td>NA Finals None</td>
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If you find errors on this page please bring them to the attention of Abu.Asaduzzaman@wichita.edu