

Syllabus

CMPE 311: C Programming and Embedded Systems

UMBC Spring 2022

Course Description

In this course, students learn about hardware and software aspects of embedded systems. Students learn C programming language through use in an embedded platform. The course builds on CMPE 310, introducing advanced topics including communication interfaces, advanced IO devices and other peripherals, multitasking, firmware, real-time operating systems/embedded operating systems and device drivers. The course will provide a hands-on experience in designing and programming an embedded system using a microcontroller-based development platform.

Course Details

Meeting Times and Locations

- Lecture
 - MW 1:00-2:15
 - Interdisciplinary Life S 230
- Discussion
 - MW 2:30pm - 3:15pm
 - Information Technology 375

Instructor

- Professor Ryan Robucci
- Department of Computer Science and Electrical Engineering
- ITE 316 Telephone x5-3549
- Email: robucci@umbc.edu
- Office Hours: I will hold my office hour after class.

Course Textbook

- Required:
 - Embedded Systems: A Contemporary Design Tool by James K. Peckol 1st edition 978-0471721802
- Recommended:
 - Embedded Microcomputer Systems: Real Time Interfacing by Jonathan W. Valvano 3rd edition 978-1111426255
 - The C Programming Language by Brian W. Kernighan and Dennis M. Ritchie 2nd edition: 013-11036208 (Paperback), 013-1103709 (hardback)
 - other recommended texts will be listed on website

Logistics

- Course website can be found under <https://eclipse.umbc.edu/robucci/cmpe311>
- Teaching Assistant: Mozhgan Navardi

Prerequisites

- Required: CMPE 310 - Systems Design and Programming

Major Learning Objectives

At the conclusion of the course, students will

- have developed programming skills in the C language;
- understand the hardware and software requirements for a microcontroller-based embedded system;
- be familiar with, and will be able to use, built-in microcontroller peripherals, including coding and building external hardware;
- be able to develop code for multi-tasking applications, and will be familiar with processes synchronization, resource sharing, and task scheduling;
- be able to install and use a real-time operating system on embedded hardware;
- be able to design and build a real-time system performing data capture, communications, and user interface.

Coursework, Grading, and Assessment

Grading of students includes the following.

- Evaluation of students will be made approximately according to the following scheme, though I reserve the right to make adjustments as I see fair and appropriate during the semester.
 - Midterm Exam: 20%
 - Final Exam: 20%
 - In-class Quizzes and assignments: 10%
 - Homework Assignments (includes programming projects): 50% (composed of several assignments with varying amounts of credit based on length and difficulty, to be used to generate a weighted average.)

Exams will evaluate the understanding of broad theoretical topics in embedded systems. The grasp of practical hardware and software knowledge will be evaluated via the implementation-based HW assignments. The ability to independently integrate the various concepts to implement an embedded system will be evaluated through projects which includes detailed reporting and working systems.

Exams and In-class Quizzes and Assignments:

There will be two exams as well as several in-class quizzes and/or assignments, given as necessary, to monitor and facilitate learning. No numerical equivalents of letter grades will be mandated in advance, except that 90% or above will be guaranteed an A, 80%+ is at least a B, 70%+ is at least a C, and 60%+ is at least a D. Based on the difficulty of each exam, students will be advised what scores correspond to what letter grades. Both absolute and relative standards will be applied to determine your grade. Quizzes will be announced when possible and appropriate, but “pop” quizzes may also be given on occasion. In-class assignments may involve group work.

Make-up Exams and In-class Quizzes and Assignments:

If an exam is missed without a really good excuse, the grade is a zero. If the exam is missed with a really good excuse and the instructor is notified in advance, there may be a make-up exam administered or the average score of the other exams may be used, at the instructor's option. You may miss one in-class quiz or assignment without penalty, in which case your other scores will be used to compute the average. For any in-class quizzes or assignments missed beyond one, the exam policy will be applied.

Homework Assignments

Students will perform regular homeworks and projects outside of class. Each of these assignments will be given along with a weight if other than 1.0. The weights will be used along with your scores to determine a weighted average to serve as the Assignments grade. Though homeworks enable me to assess the progress of students, the homeworks are primarily intended to provide hands-on learning

and self-assessment. Homeworks are valuable as a learning experience and I emphasize that more than the aspect of professor-student assessment. For instance, assistance and even answers are sometimes provided for some homework problems. Homeworks may involve book-type problems, but in this course they will be heavily based on design, coding, simulation, and experimentation. This encourages traditional theoretical study and learning, as well as learning through design and true problem solving. Homeworks are intended to teach and encourage extra study.

It is expected that students may require the professor's guidance and assistance to complete some assignments. Interaction is expected and it is your responsibility to contact me in a timely matter and get assistance to complete the assignments on-time. This encouraged opportunity for interaction with me provides for a better learning experience and also allows me to evaluate comprehension and make adjustments to the course. You must start all assignments when they are assigned, generate critical questions, identify points of assistance required, and meet with me or the TA so that you can complete the assignments on-time. Not starting the assignments early, and waiting too long to run into the difficult parts of an assignment can cost you the ability to receive time-saving assistance and severely affect your grade and satisfaction with the course.

Late work policy

Unless otherwise stated, late assignments will receive a zero.

Incomplete Grades

A grade of incomplete will be given only under exceptional circumstances described by the University policy for granting incompletes. Any such circumstance **MUST** be brought to the instructor's attention immediately as soon as it is known. Failure to complete assignments on time is not a sufficient reason for an incomplete. If you feel you are falling behind, seek help immediately.

Final Grading

If you feel you are falling behind, seek help immediately. To be fairest, your grade will be based on your performance during the semester and in this class. Please do not expect or plan to plead after the semester for final grade reconsideration except in extreme and unusual circumstances or if you think there is an accounting error. I can assure you I give due amount of consideration and care during final grade assignment. Given my grading methodology, I don't believe it is a fair practice for me to selectively reevaluate, reconsider, and change final grades upon request unless there is an exceptional circumstance. I reserve the right to make adjustments to the final grade based on displayed knowledge or circumstances that I observe during the semester, but it is your responsibility to earn your grade by completing all assignments and exams with good scores. Having said that, 90%

or above or will be guaranteed an A, 80%+ is at least a B, 70%+ is at least a C, and 60%+ is at least a D.

Academic Misconduct

The assignments in this class are for individual work. I expect that you may minimally discuss some approaches to the projects, but you may not collaborate on writing code or share or copy it with others. You may even look at small pieces of code from another student (a few lines!) so that you may help each other understand. You must never copy code or turn in anything that not representative of your learning and mastery of the material. Cheating or academic misconduct related to a assignment will make you subject to the maximum allowed penalty from the university. A zero on the assignment is only the minimum penalty. If you are stuck too late in the assignment period, and you desperately decide you need to copy something to move on to complete the rest of an assignment, you must cite your source to only receive an grade reduction as appropriate and avoid being subject to academic misconduct penalties. See <https://www.umbc.edu/policies/pdfs/UMBC III 1.10.03 Undergraduate Student Academic Conduct Policy.pdf> for policies and definitions.

All students are expected to be knowledgeable regarding all University policies on academic misconduct. By enrolling in this course, each student assumes the responsibilities of an active participant in UMBC's scholarly community in which everyone's academic work and behavior are held to the highest standards of honesty. Cheating, fabrication, plagiarism, and helping others to commit these acts are all forms of academic dishonesty, and they are wrong. Academic misconduct could result in disciplinary action that may include, but is not limited to, suspension or dismissal. To read the full Student Academic Conduct Policy, consult the UMBC Student Handbook ,the Faculty Handbook, or for graduate courses, the Graduate School website.

All work a student presents, both homework and exams, must be his or her own exclusively unless otherwise directed. Any cheating or plagiarism will not be tolerated, and will subject the student to a grade of F or worse, without any warnings. Any false or misleading representations to the instructor will also be considered as academic misconduct. By enrolling in this course, each student assumes the responsibilities of an active participant in UMBC's scholarly community in which everyone's academic work and behavior are held to the highest standards of honesty. Cheating, fabrication, plagiarism, and helping others to commit these acts are all forms of academic dishonesty and they are wrong. Academic misconduct could result in disciplinary action that may include suspension or dismissal. To read the full policy on academic integrity, consult the UMBC Student Handbook, Faculty Handbook or the UMBC Policies section of the UMBC Directory.

Tentative Schedule of Topics

1. Introduction to Microcontrollers
2. Continue Overview, Microcontroller Hardware, Parallel port pin configuration
3. Microcontroller Instructions
4. Microcontroller Instructions, Microcontroller Simulator and Debugging
5. C Programming-Basic Variable Types, Basic Operators, Type Casting, Control Structures and Boolean operations, and Arrays
6. C Programming-File Organization Functions and the Preprocessor
7. User IO and Debugging
8. C Programming-Data Type Modifiers, Bit manipulation
9. C Programming-Advanced Data Types and Pointers
10. More on Pointers, details of Pointers as variables, pointers and arrays, Memory Allocation
11. C Programming-Functions and Data Structures
12. More on Standard IO, File access, and File Streams, character string manipulation
13. Advanced C-programming Debugging
14. Advanced embedded C programming topics: Optimizing C code for embedded programming, use of assembly, fixed point math
15. Timing, Counters, Watchdog Timers
16. Communications, Microcontroller Serial Communications
17. Interrupt Service Routines(and comparison to Polling)
18. External Memory Interface, Memory Mapping
19. Multitasking and RTOS -multitasking Context Switching
20. Multitasking and RTOS -Interprocess communication and synchronization Issues
21. Multitasking and RTOS Scheduling
22. RTOS Memory and Resource Management
23. RTOS - ISRs and implementation of a Device Driver
24. Analog Interfacing
25. Other I/O features including PWM
26. Implementing a USB interface
27. Implementing a LAN Interface
28. Advanced Topics Advanced Topics
29. Course Review

Univeristy Syllabus Language for Spring 2022

(Updated August 19, 2021)

Accessibility and Disability Accommodations, Guidance and Resources (required)

Accommodations for students with disabilities are provided for all students with a qualified disability under the Americans with Disabilities Act (ADA & ADAAA) and Section 504 of the Rehabilitation Act who request and are eligible for accommodations. The Office of Student Disability Services (SDS) is the UMBC department designated to coordinate accommodations that creates equal access for students when barriers to participation exist in University courses, programs, or activities.

If you have a documented disability and need to request academic accommodations in your courses, please refer to the SDS website at sds.umbc.edu for registration information and office procedures.

SDS email: disAbility@umbc.edu

SDS phone: [410-455-2459](tel:410-455-2459)

If you will be using SDS approved accommodations in this class, please contact the instructor to discuss implementation of the accommodations. During remote instruction requirements due to COVID, communication and flexibility will be essential for success.

Sexual Assault, Sexual Harassment, and Gender Based Violence and Discrimination (required)

[UMBC Policy](#) and Federal law (Title IX) prohibit discrimination and harassment on the basis of sex, sexual orientation, and gender identity in University programs and activities. Any student who is impacted by sexual harassment, sexual assault, domestic violence, dating violence, stalking, sexual exploitation, gender discrimination, pregnancy discrimination, gender-based harassment or retaliation should contact the [University's Title IX Coordinator](#) to make a report and/or access support and resources:

Morgan Thomas, Acting Director and Title IX Coordinator

410-455-1354 (direct line), morganthomas@umbc.edu

You can access support and resources even if you do not want to take any further action. You will not be forced to file a formal complaint or police report. Please be aware that the University may take action on its own if essential to protect the safety of the community.

If you are interested in or thinking about making a report, please use the [Online Reporting/Referral Form](#). Please note that, if you report anonymously, the University's ability to respond will be limited.

Notice that Faculty are Responsible Employees with Mandatory Reporting Obligations:

All faculty members are considered *Responsible Employees*, per [UMBC's Policy on Sexual Misconduct, Sexual Harassment, and Gender Discrimination](#). Faculty are therefore required to report

any/ all available information regarding conduct falling under the Policy and violations of the Policy to the Title IX Coordinator, even if a student discloses an experience that occurred before attending UMBC and/or an incident that only involves people not affiliated with UMBC. Reports are required regardless of the amount of detail provided and even in instances where support has already been offered or received.

While faculty members want encourage you to share information related to your life experiences through discussion and written work, students should understand that faculty are required to report *past and present* sexual assault, domestic and interpersonal violence, stalking, and gender discrimination that is shared with them to the Title IX Coordinator so that the University can inform students of their [rights, resources and support](#). While you are encouraged to do so, you are not obligated to respond to outreach conducted as a result of a report to the Title IX Coordinator.

If you need to speak with someone in confidence, who does not have an obligation to report to the Title IX Coordinator, UMBC has a number of [Confidential Resources](#) available to support you:

- [The Counseling Center](#) (Main Campus): [410-455-2472](#) / After-Hours [410-455-3230](#) [Monday – Friday; 8:30 a.m. – 5 p.m.]
- [Center for Counseling and Consultation](#) (Shady Grove Campus): [301-738-6273](#) (Messages checked hourly) [Online Appointment Request Form](#)
- [University Health Services](#): [410-455-2542](#) [Monday – Friday 8:30 a.m. – 5 p.m.]
- Pastoral Counseling via [Interfaith Center](#): [410-455-3657](#); interfaith@umbc.edu [7 days a week; Fall and Spring 7 a.m. – 11 p.m.; Summer and Winter 8 a.m. – 8 p.m.]

Other Resources:

- [Women's Center](#) (for students of all genders): [410-455-2714](#); womenscenter@umbc.edu. [Monday – Thursday 10:00am-5:30pm and Friday 10:00am-4pm]
- [Shady Grove Student Resources](#), [Maryland Resources](#), [National Resources](#).

Child Abuse and Neglect:

Please note that Maryland law and [UMBC policy](#) require that faculty report all disclosures or suspicions of child abuse or neglect to the Department of Social Services and/or the police even if the person who experienced the abuse or neglect is now over 18.

Pregnant and Parenting Students

UMBC's [Policy on Sexual Misconduct, Sexual Harassment and Gender Discrimination](#) expressly prohibits all forms of Discrimination and Harassment on the basis of sex, including pregnancy. [Resources for pregnant, parenting and breastfeeding students](#) are available through the University's

Office of Equity and Inclusion. Pregnant and parenting students are encouraged to contact the Title IX Coordinator to discuss plans and ensure ongoing access to their academic program with respect to a leave of absence or return following leave related to pregnancy, delivery, adoption, breastfeeding and/or the early months of parenting.

Pregnant students and students in the early months of parenting may be entitled to accommodations under Title IX through the Office of Equity and Inclusion.

In addition, students who are pregnant and have an impairment related to their pregnancy that qualifies as disability under the ADA may be entitled to accommodations through the [Student Disability Service Office](#).

Religious Observances & Accommodations

UMBC [Policy](#) provides that students should not be penalized because of observances of their religious beliefs, and that students shall be given an opportunity, whenever feasible, to make up within a reasonable time any academic assignment that is missed due to individual participation in religious observances. It is the responsibility of the student to inform the instructor of any intended absences or requested modifications for religious observances in advance, and as early as possible. For questions or guidance regarding religious observance accommodations please contact the [Office of Equity and Inclusion](#) at oei@umbc.edu.

Hate, Bias, Discrimination and Harassment

UMBC values safety, cultural and ethnic diversity, social responsibility, lifelong learning, equity, and civic engagement.

Consistent with these principles, [UMBC Policy](#) prohibits discrimination and harassment in its educational programs and activities or with respect to employment terms and conditions based on race, creed, color, religion, sex, gender, pregnancy, ancestry, age, gender identity or expression, national origin, veterans status, marital status, sexual orientation, physical or mental disability, or genetic information.

Students (and faculty and staff) who experience discrimination, harassment, hate or bias or who have such matters reported to them should use the [online reporting/referral form](#) to report discrimination, hate or bias incidents. You may report incidents that happen to you anonymously*.* Please note that, if you report anonymously, the University's ability to respond will be limited.