Networked Embedded Systems Design

General Information

Instructor:	Fatima M. Anwar
Email:	`fanwar@umass.edu`
Class Time:	Tue/Thur 10:00 - 11:15 am
Office:	Knowles Engineering Building 209E
Office Hours:	TBD
TA	Adeel Nasrullah, `anasrullah@umass.edu`
TA Office Hours	TBD
Textbook:	Research papers, Datasheets and Web Search
Prerequisites:	Intro to Embedded Systems 231, Intro to Programming 122
Course Open to:	Seniors & Graduate students; both in ECE & CS departments

Course Description

We are surrounded by ubiquitous embedded technologies that are revolutionizing smart spaces and changing the way we build, manage, and interact with our systems. These technologies span the cloud and the edge devices, and give birth to new system designs with various constraints. The design challenges lie in providing distributed intelligence, resource optimization, and ease of integration for heterogeneous devices.

This course introduces the students to the design of embedded systems with a focus in unprecedented cyber-physical systems and internet of things applications such as health care, connected vehicles, and augmented/virtual reality. This course presents the unique capabilities of embedded technologies, and takes a holistic approach to design end-to-end systems. These systems span various thrusts that cut across both horizontal and vertical architectural layers. Focused horizontal thrusts are, 1) hardware platforms for emerging applications at the edge, 2) software for bare-metal platforms, and embedded

OS 3) network based coordination for distributed entities and 4) cloud-based services for compute-intensive tasks. It also dives into details of vertical thrusts cutting across all layers such as security-aware design, learning based modeling, and resource optimizations in current systems. Finally, the course explores system and security issues that arise with a human in the loop of embedded systems design.

The topics covered in this class equip students with the necessary skill set to research and implement embedded systems from ground up for emerging applications. Students are required to review and critique research papers assigned to them in class, actively participate and lead in discussions, define and implement a semester-long project approved by the instructor, along with presenting key findings and demonstrating the functionality of the project.

Course Topics

A combination of research papers and concepts will be covered on the following topics,

- Introduction to embedded systems with emerging applications.
- Primer on embedded systems' building blocks such as sense, compute, communicate, control, and actuate components.
- Hardware platforms and output devices with a focus on Virtual & Augmented Reality.
- Sensing modalities and their interdisciplinary research capability.
- Software organization with an emphasis on embedded OS.
- Time management and synchronization.
- Networking technologies enabling Internet of Things.
- Security risks in embedded system design.
- Resource-aware design: intermittent computing and communication.
- Intelligence at the embedded edge and cloud.
- Future directions in human in the loop embedded systems.

Grading Policy: (Note: Subject to change every semester)

30% Research Papers Discussion & Critique

15% Research / Technology Review

15%   Assignments

40%   Course Project

    Course Project's Grading Breakdown

    20%   Project Proposal, Interaction, and Updates

    40%   Quality of Work

    20%   Final Report/Paper, Peer Review

    20%   Presentation and Demonstration

Course Emphasis

This course places great emphasis on implementing projects. Students are expected to demonstrate their designed systems through hardware and/or software artifacts. These implementations can potentially lead to capstone projects and thesis options for interested students. Another emphasis of this course is on communication skills assessed through class participation, presentations, and demonstrations. Students are expected to share and discuss ideas. Each student should present her course project in various formats such as a poster presentation, and project demo to a wider audience. The purpose is to develop skills of communicating one's ideas concisely and effectively to a broader research community.

Course LMS

This term we will be using Piazza for class discussion. The system is highly catered to getting you help fast and efficiently from classmates, the TA, and myself. Rather than emailing questions to the teaching staff, I encourage you to post your questions on Piazza. Find our class signup link at: …

We will use Moodle for course management. Course content will be posted on Moodle, and assignments will be posted and graded via Moodle too.

Syllabi Statements

Health and Wellbeing. During this time, you may be experiencing new stresses related to the COVID-19 pandemic in addition to other pressures such as health, money, family, and academic concerns or stress and trauma from societal inequities and violence. You are not alone at UMass – many people care about your wellbeing and many resources are available to help you thrive and succeed. The College recognizes that coursework is challenging and that classes are not the only demand in your life. Success in this course and the College of Engineering depends heavily on your personal health and wellbeing. Recognize that stress is an expected part of the college experience, and it often can be compounded by unexpected setbacks or life changes outside the classroom such as those related to COVID-19. I strongly encourage you to reframe challenges as an unavoidable pathway to success. Reflect on your role in taking care of yourself throughout the term, before the demands of exams and projects reach their peak. Please feel free to reach out to me about any difficulty you may be having that may impact your performance as soon as it occurs and before it becomes too overwhelming. I encourage you to contact support services on campus that stand ready to assist you. You can learn about the confidential mental health services available on campus by calling the Center for Counseling and Psychological Health (CCPH) by visiting their website at umass.edu/counseling. Within the College, you may reach out to your academic advisor, the Office of Student Affairs (http://engineering.umass.edu/current-students/academics-advising) or the Office of Community Equity and Inclusion (rees@umass.edu). There are many other resources on campus for students facing personal, financial or life challenges to find support, stay in school, and graduate (https://www.umass.edu/studentlife/single-stop). Please reach out to me for support finding the resources you need.

Disability Accommodation and Inclusive Learning Statement. Your success in this class is important to me. We all learn differently and bring different strengths and needs to the class. The University of Massachusetts Amherst is committed to making reasonable, effective and appropriate accommodations to meet the needs of students with disabilities and help create a barrier-free campus. If you have a qualifying disability and require accommodations while participating in this course, please work with Disability Services to have an accommodation letter sent to me in a timely manner. If you have a disability but are not yet affiliated with Disability Services, please register with Disability Services (https://www.umass.edu/disability/students). Information on services and materials for registering are also available on their website www.umass.edu/disability. If you are eligible for exam accommodations, your exams will be administered by the exam proctoring center. Contact Disability Services immediately, and comply with their exam scheduling policies, including the requirement that you book your exams at least seven days in advance of the exam date. It is incumbent upon you contact me during the first few weeks of the semester, or shortly following registration with Disability Services, to ensure that your accommodations are being sufficiently met, including extra time and note-taking access, as applicable. Finally, beyond disability accommodations, if there are aspects of the course that prevent you from learning or make you feel excluded, please let me know as soon as possible. Together we'll develop strategies to meet both your needs and the requirements of the course.

Integrity. There is no place for a dishonest engineer! Please read and be aware of the academic honesty policy: http://www.umass.edu/dean_students/academic_policy. While this isn't something that should arise, it is something we should be aware of and discuss as a class, as integrity is a core value of the engineering profession.

Inclusivity. The diversity of the participants of this course is a valuable source of ideas, problem solving strategies, and engineering creativity. If you feel that your contribution is not being valued or respected for any reason, please speak with me privately. If you wish to communicate with

someone else in the College, speak with Assistant Dean Dr. Paula Rees (rees@umass.edu). You may also report a Climate Incident to campus at umass.edu/diversity or anonymously through the College of Engineering Climate Concerns and Suggestions on-line form (https://tinyurl.com/UMassEngineerClimate) and/or the Positive and Negative Classroom Experience online form (https://tinyurl.com/UMassEngineerClassroom). We are all members of an academic community with a shared responsibility to cultivate a climate where all individuals are valued and where both they and their ideas are treated with respect.

Pronouns and Names. Everyone has the right to be addressed by the name and pronouns that they use for themselves. Students can indicate their preferred/chosen first name and pronouns on SPIRE, which appear on class rosters. Please let me know what name and pronouns I should use for you if they are not on the roster. A student's chosen name and pronouns are to be respected at all times in the classroom. To learn more, read the Intro Handout on Pronouns: https://www.umass.edu/stonewall/sites/default/files/pronouns_intro.pdf

Gender Respect and Title IX. The University of Massachusetts Amherst aspires to be a university environment that is free of discrimination, sexual harassment, and sexual violence. Faculty have the responsibility to inform students of resources and reporting options. If you or someone you know has experienced sexual assault, sexual misconduct, or sexual discrimination please see https://www.umass.edu/titleix/what-to-do for information about resources and reporting options. A report to the Title IX Coordinator may be made at any time (including during non-business hours) by using the Title IX Coordinator's email (TitleIXCoordinator@umass.edu), telephone number (413.545.6124) or mail. UMass Amherst is committed to supporting community members who report concerns of prohibited conduct. Please reach out to me if you would like assistance connecting with any of these resources/options.