ECE597MB/622 – Embedded systems: design, modeling, and verification – Spring 2022

• **Number of Credits:**	3
• **Lecture:**	TuTh 1-2:15, E Lab 306
• **Professor:**	Daniel Holcomb, 309H KEB, holcomb@engin.umass.edu
• **Prof Office hours:**	Thursday 2:30-3:30 in Knowles 309F
• **Teaching Assistant:**	Jiteshri (JD) Dasari, jdasari@umass.edu
• **TA Lab Office hours:**	Monday 11-12 in Marcus 214
• **Piazza:**	`piazza.com/umass/spring2022/ece597mbece697mbece622/home`
• **Textbook:**	Edward A. Lee and Sanjit A. Seshia, Introduction to Embedded Systems, A Cyber-Physical Systems Approach, Second Edition, `http://LeeSeshia.org`, 2017.

Description

Embedded systems sense, actuate, compute, and communicate to accomplish tasks in domains such as medical, automotive, and industrial controls. Informal methods of hacking together embedded systems are at odds with the criticality of their applications. This course will introduce developments toward formal modeling of embedded and cyber-physical systems, and techniques for verifying properties of embedded systems. The course will give an introduction to many critical parts of embedded systems, and in particular will include a number of case studies relating to embedded security. By the end of the course, students should understand the capabilities and limitations of different representations of embedded systems, and should be able to model (and sometimes verify) simple systems using appropriate abstractions.

Major Course Topics (subject to change)

- Introduction

- Discrete Dynamics and FSMs (ch 3, 5)
- Basic Reachability Analysis

- Invariants, Temporal Logic (ch 13)
- Equivalence, Refinement/Abstraction, Simulation Relations (ch 14)
- Model Checking (ch 15)

- Hybrid Systems and Timed Automata (ch 4)

- Models of Computation (ch 6)
- Scheduling (ch 12)

- Continuous Dynamics, Sensors, ADC (ch 2, 7)

- I/O and Memory
- Security Primitives and Supply Chain

Grading Policy

In-class participation is expected. Students will be required to read and discuss research papers pertaining to the topics covered in lecture. The assigned problem sets are meant to help prepare you for the labs and exams. If your exam scores exceed your score from the problem sets, then exams will count for 55% of total grade to replace the problem sets. The participation grade will be based on Piazza activity and possibly on unannounced in-class quizzes. ECE622 students may have extra exam problems and extra steps on lab assignments.

Lab Assignments

The course will involve a number of tool-based lab assignments. The focus of these labs is modeling and verification. No advance familiarity with any tools is expected. Labs 1-3 are structured assignments, and Lab 4 will be open-ended and is a chance for each student to demonstrate their understanding of the course material on a project of their own choosing.

1. Reachability Analysis (explicit and SAT-based symbolic)
2. Verification of timed automata (using UPPAAL)
3. Hybrid verification (using PHAVER)

Grade Component	Weight
Exams (2)	50%
Problem Sets (approx. 5)	5%
Lab 1	12.5%
Lab 2	7.5%
Lab 3	7.5%
Lab 4	7.5%
Participation/Quizzes	10%

Logistics

Lecture: I will project my tablet as a whiteboard in the classroom for lecture, and will post screen capture videos from lecture afterward.

Piazza: Outside of class and office hours, questions should be asked and answered through Piazza. Different students often encounter and resolve similar issues, and public discussion on Piazza efficiently disseminates the information as it is discovered. We will also monitor and participate in the Piazza discussion. Students that are helpful on Piazza can earn bonus participation points awarded at the end of semester.

Inclusivity and Climate

My aim is for this course to be equitable, respectful, and inclusive of all participants. Achieving this requires valuing of, and sensitivity to, personal and cultural identities. You can indicate preferred name and pronouns on SPIRE, or by emailing me. I hope that our course climate will be such that you can talk to me directly if you feel unvalued. If not, I hope that you voice your concerns, anonymously if desired, through the College of Engineering Climate Concerns and Suggestions on-line form (`https://tinyurl.com/UMassEngineerClimate`). Because critical examination is an important part of learning, students are encouraged to scrutinize ideas and ask questions, and will never be evaluated negatively for doing so in the course.

Academic Honesty Policy Statement

Since the integrity of the academic enterprise of any institution of higher education requires honesty in scholarship and research, academic honesty is required of all students at the University of Massachusetts Amherst.

Academic dishonesty is prohibited in all programs of the University. Academic dishonesty includes but is not limited to: cheating, fabrication, plagiarism, and facilitating dishonesty. Appropriate sanctions may be imposed on any student who has committed an act of academic dishonesty. Instructors should take reasonable steps to address academic misconduct. Any person who has reason to believe that a student has committed academic dishonesty should bring such information to the attention of the appropriate course instructor as soon as possible. Instances of academic dishonesty not related to a specific course should be brought to the attention of the appropriate department Head or Chair. The procedures outlined below are intended to provide an efficient and orderly process by which action may be taken if it appears that academic dishonesty has occurred and by which students may appeal such actions.

Since students are expected to be familiar with this policy and the commonly accepted standards of academic integrity, ignorance of such standards is not normally sufficient evidence of lack of intent. For more information about what constitutes academic dishonesty, please see the Dean of Students' website: `http://umass.edu/dean_students/codeofconduct/acadhonesty/`

Disability Statement

The University of Massachusetts Amherst is committed to providing an equal educational opportunity for all students. If you have a documented physical, psychological, or learning disability on file with Disability Services (DS), Learning Disabilities Support Services (LDSS), or Psychological Disabilities Services (PDS), you may be eligible for reasonable academic accommodations to help you succeed in this course. If you have a documented disability that requires an accommodation, please notify me within the first two weeks of the semester so that we may make appropriate arrangements.