

ECE597MB/697MB – Embedded systems: design, modeling, and verification

- **Number of Credits:** 3
- **Lecture:** TuTh 2:30-3:45 ELAB 323
- **Office hours:** Tu 9-10 and Th 10-11
- **Professor:** Daniel Holcomb, 309H KEB, holcomb@engin.umass.edu
- **Teaching Assistant:** Harshavardhan Ramanna, hramanna@umass.edu
- **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, especially pertaining to reading and discussing research papers. Students will be required to read and discuss research papers pertaining to the topics covered in lecture. If a student has an average exam score that exceeds their average problem set score, then the exam weight will increase to 50% and the problem sets will not be counted. All students taking the 600-level course will complete an additional lab assignment that is more open-ended than the first 3. Students taking the 500-level course will have all weights scaled by 100/85 to account for not having a Lab 4 score.

Grade Component	Weight
Exams (2)	45%
Problem Sets (approx. 5)	5%
Lab 1	10%
Lab 2	7.5%
Lab 3	7.5%
Lab 4 (600-level only)	15%
Participation/Discussion	10%

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.

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

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.