ECE 697O: Real-Time Systems
Fall 2014

Real-time systems is the field of computing that involves the management of deadline-oriented computational workloads. These deadlines may be hard or soft depending on the consequences of missing them. The most prominent hard real-time systems are cyber-physical applications where computers control entities such as cars, aircraft, chemical and nuclear reactors, power plants, implanted medical devices, and robots. Soft real-time applications include streaming audio and video over the internet.

The full range of topics in this large and rapidly expanding field is much too large to cover in a single course. We will focus on the central aspects of real-time computing, especially those not covered in other courses in our department (such as networking, architecture, or fault-tolerant computing). Much of our time will be taken up in dealing with task scheduling on single- and multi-core platforms.

Students should note that this is a fairly mathematical course and should be prepared for a rigorous handling of the subject. Do not take this course if you are frightened of either algorithms or mathematics. This is an advanced course, best suited to students in their second year of graduate study, although well-prepared and motivated first-year graduate students should also be able to cope quite well with the material, especially if they are willing to put in the effort to understand the material.

The tentative list of topics to be covered is as follows (the italicized topics are time-permitting):

- Nature of cyber-physical and other real-time systems, including common misconceptions. Where do task deadlines come from?
- Performance measures for real-time systems:
  - Performability
  - Cost functions
- Uniprocessor scheduling algorithms
  - Rate Monotonic algorithm for periodic tasks
  - Earliest Deadline First algorithm for periodic tasks
  - Priority inheritance and ceiling approaches
  - Fault-tolerant task scheduling
  - Inclusion of sporadic tasks in the workload
  - Scheduling IRIS tasks
  - Scheduling end-to-end tasks
- Multiprocessor scheduling algorithms
- Power-aware task scheduling
- Thermal-aware task scheduling
- Performance measures for real-time systems:
  - Performability
  - Cost functions
- Fault-tolerant clock synchronization using phase-locking
- *Checkpointing in real-time systems*
- *Estimation of worst-case execution time*
- *Formal methods, including temporal logic*

Time Permitting

Course Grading: There will be two midterm tests and one final examination. The midterms are worth 25% each and the final 35%. Homework will amount to the remaining 15% of the grade. All tests will be closed-book.

References: There is no single textbook for this course. One useful resource is the book by Lee and Seshia, available online at http://leeseshia.org/releases/LeeSeshia_DigitalV1_08.pdf. Additional material will come from a text I coauthored with Kang Shin (on reserve in the Integrated Sciences Library). Links will be provided to any other papers we use from the technical literature.