Syllabus CSCE 496/896-003: Real-Time Systems

Spring 2016

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Course Overview

This course introduces students to the design of real-time computing systems and corresponding theory. Real-time systems applications typically involve safety or mission critical systems where timing guarantees must be maintained. Real-time task design, dependability, communication, power and energy awareness, scheduling, and real-time control are some of the topics that will be covered. The course will be biased toward real-time system design including the interactions between the physical and real-time systems - dubbed "cyber-physical systems." The course will include homework and readings from the literature, leading students toward the completion of a final project. Students will be encouraged to apply concepts to their research (if applicable) for their class project. Students should have a basic understanding of programming, system design, robotics, or computer architecture.

Class Details

Class: MWF 10:30 - 11:20 AVH 110
Final Exam Time: 7:30 - 9:30 Friday, May 6

Class website: `http://cse.unl.edu/~jbradley/courses/2016_spring/CSE496-896-real-time-systems/`

Course Requirements

Text: Kopetz, Herman. *Real-Time Systems* Springer, 2011 (ISBN: 9781441982360)
Additionally, here are a few other books that may be helpful for you. I have all of these so if you feel they would be useful let me know.

- Lee, Edward Ashford, and Sanjit Arunkumar Seshia. *Introduction to embedded systems: A cyber-physical systems approach.* Lee & Seshia, 2011.
- Alur, Rajeev. *Principles of Cyber-Physical Systems.* MIT Press, 2015.
- Wolf, Marilyn. *High-Performance Embedded Computing: Applications in Cyber-Physical Systems and Mobile Computing.* Elsevier, 2014.
- Krishna, C. Mani. *Real-Time Systems.* John Wiley & Sons, Inc., 1999.

Prerequisites: I find that students have a hard time gauging their preparedness for interdisciplinary courses (yes this will be interdisciplinary) based only on the prerequisites given. As a result, I will break it down in terms of level of preparedness:

- Unprepared:
  - No knowledge of or courses in theoretical computation, computer architecture, robotics, embedded systems, basic programming, algorithms, control theory
  - If this is you please come see me and we can talk about what to do
- Borderline prepared:
  - One course from: basic programming, computer architecture, embedded systems, or robotics
  - I will let you take the course but you should be prepared for some confusion requiring additional research and self-learning on your part
- Prepared:
  - Multiple courses from: robotics, programming, computer architecture, networking, control theory, or related
  - You should be fairly comfortable in the course building on your robotics/computing foundation

Grading

This course will require active, in-class participation as part of group discussions. There will be approximately 5 homework assignments, most of which will lead you toward success on your final project. There will be a final project consisting of a paper and presentation. Differences between graduate and undergraduate workloads are specified below.

Graduate Students

The final project should apply to your current research or something similarly ambitious. The goal will be to write a final report that can be turned into a high-quality paper for you to submit to a conference or journal with some more effort. More specific requirements on the homework and project will be given as they are assigned.

Undergraduate Students

The final project should apply to your current research (if you are engaged in any) or a project that you and I deem appropriate. The goal will be to write a high-quality final report. More specific requirements on the homework and project will be given as they are assigned.

Grade Breakdown

- in-class participation[1] - 10%
  - actively discussing topics
  - asking questions

[1] This is a subjective measure so you'll need to persuade me you have participated.

  - on-time. ***Please*** be on time. If you're consistently late I will dock you participation points relative to how often I observe you coming in late.

- homework - 50%
  - $\sim$ 10% each homework
- final project - 40%
  - presentation - 10%
  - final report - 30%

Grades will then be assigned using the following table:

A+: [98-100]	A: [93-98)	A-: [90-93)
B+: [88-90)	B: [83-88)	B-: [80-83)
C+: [78-80)	C: [73-78)	C-: [70-73)
D+: [68-70)	D: [63-68)	D-: [60-63)
F: [0-60)		

Policies

1. Attendance is not mandatory but you are responsible for anything that transpires during class...plus you want your in-class participation points!
2. Exchange of ideas and techniques is **highly** encouraged but **your work must be your own**. Also, because we are preparing you to be serious researchers and/or ethical employees you need to cite and acknowledge sources and contributions where appropriate.
   (a) All homework assignments, quizzes, exams, etc. must be your own work. No direct collaboration with fellow students, past or current, is allowed unless otherwise stated. The Computer Science & Engineering department has an Academic Integrity Policy (`http://cse.unl.edu/academic-integrity-policy`). All students enrolled in any computer science course are bound by this policy. You are expected to read, understand, and follow this policy. Violations will be dealt with on a case by case basis and may result in a failing assignment or a failing grade for the course itself.
3. All homework assignments must be typed unless otherwise specified. If you are not proficient with either LaTeX, Microsoft Word, or some other word processor or typesetting language now is your chance to learn as this will be a necessary component of your professional career.[2] If writing is difficult for you, or you are not proficient with English the UNL Writing Center (http://www.unl.edu/writing/home) may be able to help you. If I can't understand what you write I will dock you points. This is the subjective nature of writing and communicating.
4. Students have one week from time of grade posting to challenge a grade.
5. The CSE Department has an anonymous contact form that you may use to voice your concerns about any problems in the course or department if you do not wish to be identified. (`http://cse.unl.edu/contact-form`)
6. Feel free to swing by my office or contact me by email. I'd be happy to talk to you most anytime, but would appreciate setting up an appt. if you need a specific question addressed.

[2] Personally, I use LaTeX, so if that's your platform and you need technical help I can offer it. If you use Microsoft Word I will be of no use to you.

(a) Consider the Student Resource Center in Avery 12 if I am not available, or you otherwise need help: (`http://cse.unl.edu/src`)

7. Course announcements will be posted on blackboard and some may be distributed by email. Check your email regularly!

   (a) CSE Department policy dictates that students in CSE courses are expected to regularly check their email so they do not miss important announcements.

8. Students with disabilities are encouraged to contact the instructor for a confidential discussion of their individual needs for academic accommodation. It is the policy of the University of Nebraska-Lincoln to provide flexible and individualized accommodations to students with documented disabilities that may affect their ability to fully participate in course activities or to meet course requirements. To receive accommodation services, students must be registered with the Services for Students with Disabilities (SSD) office, 132 Canfield Administration, 472-3787 voice or TTY.

Schedule

This schedule is tentative and may change:

Week	Topic	Reading	HW Assigned	HW Due
1	The Real-Time Environment	RTS: Ch 1	HW1	
2	Simplicity in System Design	RTS: Ch 2	HW2	
3	Measuring Time	RTS: Ch 3		HW1
4	Real-Time Modeling	RTS: Ch 4 sztipanovits2012toward		HW2
5	Real-Time Modeling / Flexible Time		HW3	
6	Temporal Relations	RTS: Ch 5		
7	Dependability	RTS: Ch 6		
8	Real-Time Communication	RTS: Ch 7		HW3
9	System Energy	RTS: Ch 8	HW4	
10	Real-Time Operating Systems	RTS: Ch 9		
11	Spring Break - No Class	N/A	N/A	N/A
12	Real-Time Scheduling	RTS: Ch 10 liu1973scheduling	HW5	HW4
13	RT System Design	RTS: Ch 11		
14	Cyber-Physical Systems	bradley2015optimization		HW5
15	Project Presentations	N/A		
16	Project Presentations	N/A		Final Project due on final exam day