CSC 6280 – Real-Time and Embedded Systems
Section 001
Winter 2017
MW 1:00-2:15PM
0201 State Hall

Instructor:
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Course Description:
- **Graduate Bulletin Description:** Operating system design for real-time and embedded systems. Focus on scheduling, synchronization, communication, and process and memory management for time-critical and resource-constrained applications.
- **Section-Specific Description:** Real-time embedded systems have become an integral component in daily human activities such as transportation, communication, entertainment, and medicine. As an example, consider an actual implementation of an avionic control system of a helicopter: the computer control system must periodically sample the pilot's commands, perform required computation, and make mechanical adjustments every 1/40 of a second. If an adjustment, computation, or command does not complete within the approximately 25 millisecond interval, the flight control response of the helicopter will degrade (and, in the worst-case the failure will result in a crash). In such a real-time system, each computation has associated temporal constraints (e.g., each command computation must successfully complete execution on the system by a hard deadline every 25 milliseconds). Along with restrictive temporal constraints, many embedded systems operate in settings with limited available physical space and power. These physical limits severely constrain the processing speed, memory space, and other resources available to applications executing upon an embedded system and present difficult system design challenges.

In this course, we will study issues relevant to operating system design and analysis for real-time and embedded systems. We will focus on scheduling, synchronization, communication, and process and memory management for time-critical and resource-constrained applications. After the course, you should understand basic and fundamental concepts in analysis and operating system design for real-time and embedded systems.
and have a foundation to understand and critique current research in real-time and embedded systems.

Supplementary information for the course is available at http://blackboard.wayne.edu. Log on with your Access ID for class notes, lecture slides, class announcements, the course syllabus, and other information for the course.

Credit Hours: 3 Credit Hours (Lecture)

Prerequisite: CSC 4420: Computer Operating Systems or equivalent. A basic background in undergraduate discrete math, algorithm analysis, and data structures will be assumed.

Knowledge of NP-Completeness will be helpful. However, CSC 6580 is not a formal prerequisite for this course. Any material needed from CSC 6580 will be reviewed during class, if needed. Please note that I do not intend to zealously enforce the prerequisites. Anyone with a decent background in operating systems and algorithms should be able to handle the material.


Research papers will assigned throughout the semester and posted on Blackboard. Check the course Blackboard site for details and a reading schedule. It is expected that students will have read the assigned material prior to lecture and will be prepared to discuss the material.

(Optional) Textbooks:

Course contents: (Tentative List of Topics) Real-time task models and specifications; scheduling algorithms; clock-driven scheduling; priority-driven scheduling; non-preemptivity; timing analysis; schedulability analysis; resource-sharing; mixed real-time and non-real-time scheduling; distributed and multiprocessor systems; real-time kernel design and overview; real-time application considerations; embedded system considerations; real-time verification and logic.

A schedule of topics and reading assignments may be found on the Blackboard website. Please check this site often for any changes to the schedule or announcements.

Course Learning Objectives:

Upon successful completion of this class, the student will be able to:
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<tr>
<th>#</th>
<th>CSC 6280 Course Learning Objectives</th>
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<tbody>
<tr>
<td>1</td>
<td>Identify the major differences and design challenges for real-time systems compared to traditional performance-based computing systems.</td>
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<tr>
<td>2</td>
<td>Perform schedulability analysis for standard real-time task/scheduling models, accounting for various system complexities (e.g., resource-sharing, non-preemptivity, etc).</td>
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<td>3</td>
<td>Evaluate, compare, and contrast different scheduling algorithms and real-time and embedded kernel designs.</td>
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<td>4</td>
<td>Summarize and critique the major contributions of recent research publications in the real-time and embedded systems area.</td>
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<td>5</td>
<td>Apply knowledge of real-time and embedded system concepts to address an open research question in real-time and embedded systems and related fields.</td>
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**Assessment:**

*Attendance & Class-Discussion Participation 5%*

*Three Homeworks 20%*

*Paper Presentation & Discussion (1-2 papers per student) 10%*

*Class-Project Presentation 25%*

*Class-Project Technical Report 40%*

**Grading Scale:**

- 95 - 100% A
- 80 - 82% B-
- 90 - 94% A-
- 77 - 79% C+
- 87 - 89% B+
- 70 - 76% C
- 83 - 86% B
- 69 or below F

**Homework:** There will be three homework assignments in the course. Homework assignments will be given roughly once a month. Some of the assignments problems pertaining to scheduler implementation, operating system design, and/or experimental analysis will involve programming. *All homework assignments must be completed individually.* It is not acceptable to discuss possible approaches for solving the assigned problems unless permission is explicitly given by the instructor. Any collaboration on homework assignments will be considered cheating. A student caught cheating will receive a grade of "F" for the assignment (and potentially the course) and face charges with the University Judicial Officer. (For more details, see *Academic Dishonesty* section below).

Homework assignments are due in class at the beginning of lecture on the due date given. No late homeworks will be accepted.

**Exams:** There will be no exams for this course.

**Class Participation:** Attendance is mandatory for this course. I understand that excused absences are occasionally necessary; however, I request that you inform me of your absence prior to the missed lecture either by email or in-person.
A course in which students actively participate in the discussion of ideas is always much more enjoyable and stimulating. In fact, 5% of your grade is determined by participation in the class discussions. Students who routinely participate in class will receive full marks for this portion of the grade. However, I also reserve the right to deduct points for those who routinely do not participate in discussion, come to class late, use their phone/tablets/laptop for non-course related activities, or sleep in class, text etc.

**Reading Presentation:** Each student will be required to present at least one research paper from a real-time and/or embedded systems conference or journal. A list of potential papers will be made available early in the semester; each student will choose a paper from the list or suggest a paper (approved by me). A sign-up sheet will also be circulated early in the semester. Each presentation will be evaluated on quality of summary, student's grasp of topic, ability to handle questions, and presentation style.

**Class Project:** A significant portion of the course grade is the required class project. In this course, you will be responsible for designing your own project. Your project can be either experimental investigation or a research project on an open topic in real-time systems. The project must be a fairly significant piece of work. It is acceptable to use research from a current GRA or research position as the basis for your class project. However, your project may not be based on work from another course without the permission of me and the instructor for the other course (permission will be granted only if the total work involved is commensurate with the amount of effort expected in both courses combined). Two-person projects may be permitted, provided the total work involved is about twice that of the typical single-person project.

The components of the class project that will be graded are a class presentation and a technical report describing the project. The class presentation will occur during the course's scheduled final exam time. Officially, the technical report of the project will be due on the last day of class. In addition, each student will be required to submit an initial informal project proposal early in the semester, and a more detailed project proposal later. Details on class projects will be discussed in greater detail during the second or third week of class.

**Religious Holidays:** Because of the extraordinary variety of religious affiliations of the University student body and staff, the Academic Calendar makes no provisions for religious holidays. However, it is University policy to respect the faith and religious obligations of the individual. Students with classes or examinations that conflict with their religious observances are expected to notify their instructors well in advance so that mutually agreeable alternatives may be worked out.

**Student Disabilities Services:**
- If you have a documented disability that requires accommodations, you will need to register with Student Disability Services for coordination of your academic accommodations. The Student Disability Services (SDS) office is located in the Adamany Undergraduate Library. The SDS telephone number is 313-577-1851 or 313-202-4216 (Videophone use only). Once your accommodation is in place, someone can meet with
you privately to discuss your special needs. Student Disability Services' mission is to assist the university in creating an accessible community where students with disabilities have an equal opportunity to fully participate in their educational experience at Wayne State University.

- Students who are registered with Student Disability Services and who are eligible for alternate testing accommodations such as extended test time and/or a distraction-reduced environment should present the required test permit to the professor at least one week in advance of the exam. Federal law requires that a student registered with SDS is entitled to the reasonable accommodations specified in the student’s accommodation letter, which might include allowing the student to take the final exam on a day different than the rest of the class.

**Academic Dishonesty - Plagiarism and Cheating:** Academic misbehavior means any activity that tends to compromise the academic integrity of the institution or subvert the education process. All forms of academic misbehavior are prohibited at Wayne State University, as outlined in the Student Code of Conduct (http://www.doso.wayne.edu/student-conduct-services.html). Students who commit or assist in committing dishonest acts are subject to downgrading (to a failing grade for the test, paper, or other course-related activity in question, or for the entire course) and/or additional sanctions as described in the Student Code of Conduct.

- **Cheating:** Intentionally using or attempting to use, or intentionally providing or attempting to provide, unauthorized materials, information or assistance in any academic exercise. Examples include: (a) copying from another student’s test paper; (b) allowing another student to copy from a test paper; (c) using unauthorized material such as a "cheat sheet" during an exam.
- **Fabrication:** Intentional and unauthorized falsification of any information or citation. Examples include: (a) citation of information not taken from the source indicated; (b) listing sources in a bibliography not used in a research paper.
- **Plagiarism:** To take and use another’s words or ideas as one’s own. Examples include: (a) failure to use appropriate referencing when using the words or ideas of other persons; (b) altering the language, paraphrasing, omitting, rearranging, or forming new combinations of words in an attempt to make the thoughts of another appear as your own.
- **Other** forms of academic misbehavior include, but are not limited to: (a) unauthorized use of resources, or any attempt to limit another student’s access to educational resources, or any attempt to alter equipment so as to lead to an incorrect answer for subsequent users; (b) enlisting the assistance of a substitute in the taking of examinations; (c) violating course rules as defined in the course syllabus or other written information provided to the student; (d) selling, buying or stealing all or part of an un-administered test or answers to the test; (e) changing or altering a grade on a test or other academic grade records.

**Course Drops and Withdrawals:** In the first two weeks of the (full) term, students can drop this class and receive 100% tuition and course fee cancellation. After the end of the second week there is no tuition or fee cancellation. Students who wish to withdraw from the class can initiate a withdrawal request on Pipeline. You will receive a transcript notation of WP (passing), WF (failing), or WN (no graded work) at the time of withdrawal. No withdrawals can be initiated after the end of the tenth week. Students enrolled in the 10th week and beyond will receive a
grade. Because withdrawing from courses may have negative academic and financial consequences, students considering course withdrawal should make sure they fully understand all the consequences before taking this step. More information on this can be found at: http://reg.wayne.edu/pdf-policies/students.pdf

Student services:

- The Academic Success Center (1600 Undergraduate Library) assists students with content in select courses and in strengthening study skills. Visit www.success.wayne.edu for schedules and information on study skills workshops, tutoring and supplemental instruction (primarily in 1000 and 2000 level courses).
- The Writing Center is located on the 2nd floor of the Undergraduate Library and provides individual tutoring consultations free of charge. Visit http://clasweb.clas.wayne.edu/writing to obtain information on tutors, appointments, and the type of help they can provide.

Class recordings: Students need prior written permission from the instructor before recording any portion of this class. If permission is granted, the audio and/or video recording is to be used only for the student’s personal instructional use. Such recordings are not intended for a wider public audience, such as postings to the internet or sharing with others. Students registered with Student Disabilities Services (SDS) who wish to record class materials must present their specific accommodation to the instructor, who will subsequently comply with the request unless there is some specific reason why s/he cannot, such as discussion of confidential or protected information.