

CS 721 Real-Time and Embedded Systems

University of Nevada, Las Vegas

Instructor:

Name:

Email:

Office address:

Office hours:

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.

Credit Hours:

3 credit hours (Lecture)

Prerequisites:

CS 370 Operating Systems or equivalent. A basic background in undergraduate discrete math, algorithm analysis, and data structures is required.

It will be helpful to take CS 677 Analysis of Algorithms, but it is not a formal prerequisite. Any material needed from CS 677 will be reviewed during class, if needed. Please note that the instructor does not intend to zealously enforce the prerequisites. Anyone with a decent background in operating systems and algorithms should be able to handle the material.

Required Reading:

Hard Real-Time Computing Systems: Predictable Scheduling Algorithms and Applications, Giorgio C. Buttazzo, Springer, Third Edition, 2011.

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

Optional Textbooks:

Real-Time Systems, Jane Liu, Prentice Hall, 2000.

Real-Time Systems, C.M. Krishna and K.G. Shin, McGraw Hill, 1997.

High-Embedded Computing: Architectures, Applications, and Methodologies. Wayne Wolf, Morgan-Kaufman, 2007.

Course Learning Objectives:

The purpose of this course is to provide students an in depth understanding of real-time operating systems, and embedded systems. After the successful completion, students should be able to

1. Identify the major differences and design challenges for real-time systems compared to traditional performance-based computing systems.
2. Perform schedulability analysis for standard real-time task/scheduling models, accounting for various system complexities (e.g., resource-sharing, non-preemptivity, etc).
3. Evaluate, compare, and contrast different scheduling algorithms and real-time and embedded kernel designs.

Assignments are due before the beginning of the class on the given due date. Late Assignments will not be accepted.

Exams:

There will be no exams for this course.

Class Participation:

Attendance is mandatory for this course. Although excused absences are occasionally necessary, students should inform the instructor about an absence prior to the missed lecture by email.

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 the class will receive full points for this portion of the grade. However, the instructor also reserves the right to deduct points for those who routinely do not participate in the discussion, come to class late, use their phone/tablets/laptop for non-course-related activities, text, or sleep in class, 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

Public Health Directives

Face coverings are currently mandatory for all faculty and students in the classroom. Students must follow all active UNLV public health directives while enrolled in this class. UNLV public health directives are found at [Health Requirements for Returning to Campus](https://www.unlv.edu/coronavirus/health-requirements), <https://www.unlv.edu/coronavirus/health-requirements>. Students who do not comply with these directives may be asked to leave the classroom. Refusal to follow the guidelines may result in further disciplinary action according to the [UNLV Student Conduct Code](https://www.unlv.edu/sites/default/files/page_files/27/StudentConduct-Code.pdf), https://www.unlv.edu/sites/default/files/page_files/27/StudentConduct-Code.pdf, including being administratively withdrawn from the course.

To the greatest extent possible, all graded assignments and assessments in UNLV online courses should be hosted in WebCampus-Canvas or another UNLV-managed platform that requires ACE login credentials for access.

Incomplete Grades

fourths of course work for that semester/session, but cannot complete the last part of the course

believes that the student can finish the course without repeating it. For undergraduate courses, the incomplete work must be made up before the end of the following regular semester. Graduate -, 600-, or 700-level courses have up to one calendar year to complete the work, at the discretion of the instructor. If course requirements are not completed

adjusted accordingly. Students who are fulfilling an Incomplete grade do not register for the course, but make individual arrangements with the instructor who assi

Library Resources

Librarians are available to consult with students on research needs, including developing research topics, finding information, and evaluating sources. To make an appointment with a

This policy will not apply in the event that completing the assignment or administering the examination at an alternate time would impose an undue hardship on the instructor or the University that could be reasonably avoided. There should be a good faith effort by both the instructor and the student to agree to a reasonable resolution. When disagreements regarding this policy arise, decisions can be appealed to the Department Chair/School Director, College/School Dean, and/or the Faculty Senate Academic Standards Committee.

For purposes of definition, extracurricular activities may include, but are not limited to academic recruitment activities, competitive intercollegiate athletics, fine arts activities, liberal arts competitions, science and engineering competitions, and any other event or activity sanctioned by a College/School Dean, and/or by the Executive Vice President and Provost.

Rebelmail

st ways in which students receive official University communications, information about deadlines, major Campus events, and announcements. All UNLV students receive a Rebelmail account after they have been admitted to the University. Sending emails within WebCampus-Canvas is also acceptable.

Tutoring and Coaching

The Academic Success Center (ASC), at the Claude I. Howard Building, provides tutoring, academic success coaching, and other academic assistance for all UNLV undergraduate students. For information regarding tutoring subjects, tutoring times, and other ASC programs and services, please visit the [ASC website](https://www.unlv.edu/asc), <https://www.unlv.edu/asc>, or call 702-895-3177. The ASC is located across from the Student Services Complex (SSC). Academic success coaching is located on the second floor of SSC A, Room 254. Drop-in tutoring is located on the second floor of the Lied Library, and on 6(S)-3(S)-3(C)-2(A, Room) JTJET@.00000912 0 612 792 reW*n F87s 0/F1 12 Tf1 0