COURSE SYLLABUS

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YEAR COURSE OFFERED: 2022

SEMESTER COURSE OFFERED: Spring

DEPARTMENT: Computer Science

COURSE NUMBER: COSC 4331 / 6384

NAME OF COURSE: Real-Time Systems and Embedded Programming / Real-Time Systems

NAME OF INSTRUCTOR: Albert M. K. Cheng

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The information contained in this class syllabus is subject to change without notice. Students are expected to be aware of any additional course policies presented by the instructor during the course.

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Learning Objectives

Computers are increasingly employed to monitor and control physical processes and systems. These real-time embedded systems must satisfy stringent timing and reliability constraints in addition to functional correctness requirements. Examples of these embedded systems include the new generation of airplane avionics, autonomous vehicles, Space Station control software, high-performance network and telephone switching systems, medical monitoring instruments, multimedia tools, virtual reality systems, robotic controllers, and emerging Internet-of-Things (IoT) and Cyber-Physical Systems (CPS).

This course introduces a formal framework and powerful techniques for the design and development of this class of systems. These theoretical foundations are followed by hands-on practice in employing these advanced techniques to build, analyze, and verify different modules of actual real-time systems. Scheduling tools and RTOSs (such as VxWorks) and Wind River Workbench/Tornado development tools are introduced. Programming in real-time/rule-based languages such as Ada, EQL, MRL, and OPS5 is described. Specification and verification tools such as Statechart, Modechart, and Estella are used to help design experimental real-time systems. Embedded programming techniques are studied. The course also serves as a forum for discussing state-of-the-art research topics in real-time systems design.

Alumni of this course have joined prestigious academic and governmental institutions as well as leading companies such as NASA, Harvard U., Yale U., NYU, Duke U., Rice U., Virginia Tech, U. of Ljubljana, UH, UH-Clear Lake, Texas A&M, NC State, Intel, AMD, HP, Microsoft, Amazon, Facebook, Oracle, Nokia Bell Labs (formerly AT&T Bell Labs), Samsung, Uber, Cisco, Halliburton, BMC Software, Aspen Technology, GE, Johnson Controls, VMWare, Emerson, Roku, Shell, JP Morgan Chase, and more.

Major Assignments/Exams

Several (typically 3) homework assignments (25%), one open-book in-class midterm exam (no final exam) with webcam turned on (35%), one project report (25%), and one project presentation (15%).

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Required Reading

Real-Time Systems: Scheduling, Analysis, and Verification by Prof. Albert M. K. Cheng (Publisher: John Wiley & Sons).

List of discussion/lecture topics

Introduction to real-time and embedded systems, Internet-of-Things (IoT) and Cyber-Physical Systems (CPS).

System decomposition and scheduling techniques

In-depth study of Rate-Monotonic Scheduler (RMS), EDF, LLF, and other schedulers

Programming language and operating systems support

Wind River VxWorks RTOS and Workbench/Tornado Development Tools

Formal specification, analysis, and verification techniques

Embedded programming techniques

Real-time rule-based expert systems

Fault detection, fault recovery, and reliability issues

Time-critical distributed systems and communication networks

University of Houston – Policies and Guidelines

COVID-19 Information
Students are encouraged to visit the University's COVID-19 website for important information including on-campus testing, vaccines, diagnosis and symptom protocols, campus cleaning and safety practices, report forms, and positive cases on campus. Please check the website throughout the semester for updates.

Vaccinations
Data suggests that vaccination remains the best intervention for reliable protection against COVID-19. Students are asked to familiarize themselves with pertinent vaccine information, consult with their health care provider. The University strongly encourages all students, faculty and staff to be vaccinated.

Reasonable Academic Adjustments/Auxiliary Aids
The University of Houston complies with Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990, pertaining to the provision of reasonable academic adjustments/auxiliary aids for disabled students. In accordance with Section 504 and ADA guidelines, UH strives to provide reasonable academic adjustments/auxiliary aids to students who request and require them. If you believe that you have a disability requiring an academic adjustments/auxiliary aid, please contact the Justin Dart Jr. Student Accessibility Center (formerly the Justin Dart, Jr. Center for Students with DisABILITIES).

Excused Absence Policy
Regular class attendance, participation, and engagement in coursework are important contributors to student success. Absences may be excused as provided in the University of

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Houston Undergraduate Excused Absence Policy and Graduate Excused Absence Policy for reasons including: medical illness of student or close relative, death of a close family member, legal or government proceeding that a student is obligated to attend, recognized professional and educational activities where the student is presenting, and University-sponsored activity or athletic competition. Under these policies, students with excused absences will be provided with an opportunity to make up any quiz, exam or other work that contributes to the course grade or a satisfactory alternative. Please read the full policy for details regarding reasons for excused absences, the approval process, and extended absences. Additional policies address absences related to military service, religious holy days, pregnancy and related conditions, and disability.

Recording of Class

Students may not record all or part of class, livestream all or part of class, or make/distribute screen captures, without advanced written consent of the instructor. If you have or think you may have a disability such that you need to record class-related activities, please contact the Justin Dart, Jr. Student Accessibility Center. If you have an accommodation to record class-related activities, those recordings may not be shared with any other student, whether in this course or not, or with any other person or on any other platform. Classes may be recorded by the instructor. Students may use instructor's recordings for their own studying and notetaking. Instructor's recordings are not authorized to be shared with *anyone* without the prior written approval of the instructor. Failure to comply with requirements regarding recordings will result in a disciplinary referral to the Dean of Students Office and may result in disciplinary action.

Syllabus Changes

Due to the changing nature of the COVID-19 pandemic, please note that the instructor may need to make modifications to the course syllabus and may do so at any time. Notice of such changes will be announced as quickly as possible through (*specify how students will be notified of changes*).

Resources for Online Learning

The University of Houston is committed to student success, and provides information to optimize the online learning experience through our Power-On website. Please visit this website for a comprehensive set of resources, tools, and tips including: obtaining access to the internet, AccessUH, and Blackboard; requesting a laptop through the Laptop Loaner Program; using your smartphone as a webcam; and downloading Microsoft Office 365 at no cost. For questions or assistance contact UHOnline@uh.edu.

UH Email

Please check and use your Cougarnet email for communications related to this course. To access this email, login to your Microsoft 365 account with your Cougarnet credentials.

Webcams

Access to a webcam is required for students participating remotely in this course. Webcams must be turned on *during exams to ensure the academic integrity of exam administration*.

Honor Code Statement

Students may be asked to sign an honor code statement as part of their submission of any graded work including but not limited to projects, quizzes, and exams: " *I understand and agree to abide by the provisions in the (select: University of Houston Undergraduate Academic Honesty Policy , University of Houston Graduate Academic Honesty Policy). I understand that academic honesty is taken very seriously and, in the cases of violations, penalties may include suspension or expulsion from the University of Houston."*

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Course Delivery Formats and Exams

Synchronous Online Courses: This course is being offered in the Synchronous Online format. Synchronous online class meetings will take place according to the class schedule. There is no face-to-face component to this course. In between synchronous class meetings, there may also be asynchronous activities to complete (e.g., discussion forums and assignments). Each exam will be delivered in the synchronous online format, and the specified date and time will be announced during the course. Prior to the exam, descriptive information, such as the number and types of exam questions, resources and collaborations that are allowed and disallowed in the process of completing the exam, and procedures to follow if connectivity or other resource obstacles are encountered during the exam period, may be provided.

Helpful Information

Coogs Care: https://www.uh.edu/dsaes/coogscare/

Student Health Center: https://www.uh.edu/healthcenter/

Counseling and Psychological Services (CAPS) can help students who are having difficulties managing stress, adjusting to college, or feeling sad and hopeless. You can reach CAPS (www.uh.edu/caps) by calling 713-743-5454 during and after business hours for routine appointments or if you or someone you know is in crisis. Also, there is no appointment necessary for the "Let's Talk" program, which is a drop-in consultation service at convenient locations and hours around campus.