

Real-Time Operating System, Syllabus

CSCE 4620: Real-Time Operating System, University of North Texas

Instructor Contact

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Course Description

Basic real-time operating systems concepts and services, including interrupt processing, process and thread models, real-time software architectures and development environments. Detailed study of the design and implementation of real-time applications using real-time operating systems. Focus on commercial real-time operating systems/development environments, including vxWorks, RTOS and pOSEK/pOSEKSystem.

Course Structure

[*I reserve the right to modify course policies, the course calendar, assignment or project point values, and due dates.]**

Meeting in NTDP E265 on Tuesday and Thursday from 2:30 PM – 3:50 PM, this class is held in person, face to face.

Week		Lecture	Assignments
1	8/18-8/24	Syllabus, Introduction to real-time systems and OSes	
2	8/25-8/31	RTOS services, real-time tasks	
3	9/1-9/7	Periodic, aperiodic and sporadic tasks scheduling	Assignment 1
4	9/8-9/14	Periodic, aperiodic and sporadic tasks scheduling	
5	9/15-9/21	Periodic, aperiodic and sporadic tasks scheduling	Assignment 2
6	9/22-9/28	Periodic, aperiodic and sporadic tasks scheduling	Quiz 1
7	9/20-10/5	Multiprocessor Scheduling	Assignment 3

8	10/6-10/12	ROS, Semaphores and synchronization	
9	10/13-10/19	Semaphores and synchronization, Energy Efficient RT System	
10	10/20-10/26	RTOS memory management	Assignment 4
11	10/27-11/2	Exceptions and interrupts	Quiz 2
12	11/3-11/9	Timer	
13	11/10-11/16	Paper Presentation	Paper/Project
14	11/17-11/23	Review, Comprehensive Exam	Exam
15	11/24-11/30	Thanksgiving break	
16	12/1-12/7	Paper Presentations	

Attendance Expectations and Consequences

Regular attendance and active participation are expected in this course. Students are responsible for all material covered in class, including announcements, discussions, assignments, and schedule changes.

- Excused absences (e.g., illness, university-sponsored activities, family emergencies) must be supported by appropriate documentation and communicated to the instructor as soon as possible.
- Unexcused absences may negatively impact the participation component of the course grade. Excessive absences may also affect a student's ability to succeed in the course.
- Students are responsible for making up missed work, quizzes, or exams in accordance with the instructor's guidelines.

Eagle Alert Notice & Calendar Changes

UNT uses a system called **Eagle Alert** to quickly notify students with critical information in the event of an emergency (i.e., severe weather, campus closing, and health and public safety emergencies like chemical spills, fires, or violence). Please note that the **course calendar is subject to change** in accordance with the [Campus Closures Policy](#). Any updates to the schedule, assignments, or other course activities will be communicated promptly through Canvas and/or email.

Course Prerequisites

CSCE 3600: Principals of Systems Programming.

Course Objectives

This course is about the design of real-time operating systems. We will learn basic real-time operating systems concepts and services, including interrupt processing, process and thread models, real-time software architectures and development environments. We will also study in detail the design and implementation of real-time applications using real-time operating systems.

Commercial real-time operating systems/development environments, including Robot Operating System (ROS), will be discussed in case studies. The outcomes of this course are:

1. Understand the differences between general purpose and realtime operating systems.
2. Understand multithreading in real-time environment.
3. Understand task and thread scheduling in real-time operating systems.
4. Understand memory management in real-time system.
5. Be able to program using system proved timers, signals, mutual exclusion, semaphores, message queues and exception handlers.
6. Be able to program real-time applications to run in a realistic operating environment.

Course Outcome

1. Differentiate real-time vs. general-purpose operating systems.
2. Apply scheduling algorithms for periodic, aperiodic, and sporadic tasks.
3. Use synchronization mechanisms (e.g., semaphores, mutexes, message queues).
4. Describe how timers, interrupts, and exceptions are managed in real-time operating systems.
5. Evaluate memory management techniques in real-time systems.
6. Deploy applications using commercial RTOS (e.g., ROS, VxWorks, pOSEK).

Teaching Philosophy & Learning Environment

My goal is to foster a collaborative and inclusive environment where students can build both confidence and competence. I encourage curiosity, critical thinking, and respectful discussion as we explore course concepts together.

Materials

All materials (readings, videos, tutorials, assignments and exams) will be accessible on Canvas and posted on the course modules. Readings will all be fairly dense, so please search for additional resources (e.g. wikipedia, coursera lectures) as needed. All attempts will be made to provide sufficient resources for everyone.

Textbook:

Real Time Concepts for Embedded Systems by Qing Li CRC Press, 2003. ISBN: 1-578220-124-1

Recommended Readings:

Real-Time Systems by Jane W. S. Liu Prentice Hall, 2000. ISBN: 0-13-099651-3

Operating System Concepts (10th Ed.) by Abraham Silberschatz Wiley, 2018. ISBN: 1-11-945633-9.

Course communication

This course will use the **Canvas** learning management system (LMS) to distribute course materials, communicate and collaborate online, post grades, and submit assignments. You are responsible for

checking the Canvas course site regularly for class work and announcements. You may find the Online Communication Tips (<https://clear.unt.edu/online-communication-tips>) helpful. Should you have any questions about the course or material in general, you may attend your instructor's office hours or **use your UNT e-mail address** to e-mail your instructor directly at the e-mail address listed above with CSCE 4620 in the subject line. Every attempt will be made to answer e-mails within 24 hours, but if no reply is received within this time frame, please follow up with your instructor again to ensure a response.

For assistance with assignments or questions about grading of a particular assignment, you may also contact the TAs/IAs assigned to this directly via e-mail or during their office hours. This information will be available on Canvas.

Grades will be posted on Canvas throughout the semester to provide an ongoing assessment of student progress, but typically about one week after the assignment was due. Grading disputes should first go to the TA that graded your assignment, but if a resolution cannot be reached between the student and the grader, then you should go to the instructor who will have the final say on the grade.

Course Technology & Skills

Digital Learning Requirements

This course has digital components. To fully participate, students will need: Reliable internet access to reference course content on the Canvas Learning Management System (LMS).

Minimum Technology Requirements

- Computers are required throughout the course.
- Microsoft Office Suite
- Microphone
- Webcam
- Quizzes and exams will use the Canvas quiz system.
 - [Canvas Technical Requirements](#)

Information on how to be successful in a digital learning environment can be found at Learn Anywhere (<https://online.unt.edu/learn>).

Course Requirements

Assignments: There will be approximately four assignments assigned during the semester. All assignments, shall be turned in electronically using the Canvas. If you are having trouble with the assignment, please consult with your instructor, TAs, or Peer Mentors associated with the class. Assignments are to be turned in individually, although students are encouraged to work together extensively. As observed below in class grade points, these small assignments will have minimal impact on grades - they are for learning and self- evaluation rather than grading.

Quizzes: There will be two quizzes during the scheduled quiz time. All students are expected to take the exams/quizzes during the scheduled time period. **You will have 30 minutes to do the quiz questions and we then discuss all the quiz questions together and the rest of the class time is for you to modify your answer and submit your corrected answer to me.**

Exam: There will be one comprehensive exam. Time will be limited, and all work will be individual. All students are expected to take the exams during the scheduled time period.

You are allowed to bring a cheat sheet (A4 size, double sides).

Missed exam: The exam cannot be missed without prior arrangements or later documented proof of extenuating circumstances.

Paper Presentation: Each group (up to 3 team members) will select one research paper from the list of recommended conferences:

- IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS) (<http://2022.rtas.org/accepted-papers/Links to an external site.>, <http://2021.rtas.org/program/Links to an external site.>, <http://2020.rtas.org/conference-schedule-2/Links to an external site.>)
- IEEE Real-Time Systems Symposium (RTSS) (<http://2022.rtss.org/conference-program/Links to an external site.>, <http://2021.rtss.org/conferenceformat/Links to an external site.>, <http://2020.rtss.org/program/Links to an external site.>)
- ACM International Conference on Internet of Things (IoT) (<https://iot-conference.org/iot2022/programLinks to an external site.>, <https://iot-conference.org/iot2021/programLinks to an external site.>, <https://iot-conference.org/iot2020/programLinks to an external site.>)
- IEEE Intelligent Vehicles Symposium (IV) (<https://its.paperecept.net/conferences/conferences/IV21/program/Links to an external site.>, <https://ieeexplore.ieee.org/xpl/conhome/9304518/proceedingLinks to an external site.>)

The selected paper must have been published within the past ten years.

The presentation must be prepared collaboratively by all group members, with slides submitted electronically via Canvas before your scheduled presentation date. If you have questions about paper selection, content, or presentation requirements, please consult the instructor for this course.

Paper presentations will be delivered during scheduled class time. Each group is expected to clearly explain the research problem, key contributions, methodology, and results, as well as provide critical analysis and discussion (~20 minutes).

Grading

Grades are determined by a simple points system, with a total of *at least* 100% as the goal though more than 100% are likely. The expected distribution of points is given below, with the exact scale determined by point values given for each task or exam - this is subject to minor modification based on actual points given. Note, even though the majority points are on projects, exams are also a significant means of establishing your final grade, so please complete the Canvas take-home quizzes and assignments in a timely way and study appropriately prior to each exam.

- Assignments: 30%
- Quizzes: 20%
- Paper Presentation: 20%
- Exam: 30%
- Bonus Points:
 - Attendance 3% [We will check for the attendance around 8 times, if you attend 7-8 time, 3% bonus points will be given, 4-6 times, 2% bonus, 1-3 times, 1% bonus, otherwise 0% bonus.]
 - SPOT: 3%-5%

Grading Scale: A=90, B=80-89.9, C=70-79.9, D=60-69.9, F=0-59.9 pts. No exceptions. If class grades are low (e.g. I expect the vast majority of students will end with A's and B's), extra quizzes or assignments will be given to add points to the class.

Late Work

All assignments, shall be turned in electronically using the Canvas. Any work turned in late for the **0-24 hours will not receive a penalty, late for 24-48 hours will receive a 50% penalty and 48-72 hours will receive 75% penalty, and it will not be accepted after 72 hours.** All work turned in after 48 hours of the deadline will receive a grade of zero unless the student has a [university-excused absence](#) to an external site. and provides documentation with 48 hours of the missed deadline.

GenAI Use

In this course, you are encouraged to use Generative AI (GenAI) tools such as [insert tool(s) here, e.g., Claude, ChatGPT, Gemin] to support your learning and develop skills for a GenAI-oriented workforce. This use will help us stay technically proficient and ethically grounded. However, GenAI should complement, not replace, our course materials. If something seems unclear, feel free to ask.

I use GenAI to [insert action(s) here, e.g., enhance materials, streamline tasks, generate prompts, create scenarios, draft syllabi, build study guides, analyze performance]. I will always disclose how I use GenAI, and I expect the same from you.

In line with the UNT Honor Code, all work you submit must be your own. Using GenAI tools without attribution or relying on them to complete assignments violates academic integrity and will be addressed according to our policy.

Examination Policy

The comprehensive exams will be held in-person during the scheduled class time. It is close book, close note unless otherwise specified in advance, however, no communication with others other than the instructor or the TA is allowed in any form (e.g., email, chatting, etc.). **Anyone involved in cheating (copying other students' exams, helping others cheat, etc.) will be reported to the university and receive an F in the final grade.** Exams cannot be missed. Any accommodations must be given by prior arrangement with the instructor, otherwise documentation proving an extenuating circumstance will have to be provided after the missed exam. Exams are expected to be cumulative in scope.

Technical Errors during Exams

If during the exam there is a technical error which affects your ability to submit the exam, you should immediately notify the instructor and the TAs.

Instructor/TA Responsibilities and Feedback

Instructor responsibilities include: helping students grow and learn, providing clear instructions for projects and assessments, answering questions about assignments, identifying additional resources as necessary, providing grading rubrics, reviewing and updating course content, etc.

TA responsibilities include: grading assignments and exams, answering questions about assignments, helping students grow and learn.

Estimated timeline for feedback:

- Assignments and exams are graded within a week since submission;
- Emails are responded within 24 hours during the work week (M-F);
- Messages on Canvas are not recommended, and might not receive a response.
- Comments on Canvas are only used for TAs to provide feedback to students; student's comments won't be read - send an email instead.

UNT Policies

Academic Integrity Policy

Academic Integrity Standards and Consequences. According to [UNT Policy 06.003](#), Student Academic Integrity, academic dishonesty occurs when students engage in behaviors including, but not limited to cheating, fabrication, facilitating academic dishonesty, forgery, plagiarism, and

sabotage. A finding of academic dishonesty may result in a range of academic penalties or sanctions ranging from admonition to expulsion from the University.

ADA Policy

UNT makes reasonable academic accommodation for students with disabilities. Students seeking accommodation must first register with the Office of Disability Accommodation (ODA) to verify their eligibility. If a disability is verified, the ODA will provide a student with an accommodation letter to be delivered to faculty to begin a private discussion regarding one's specific course needs. Students may request accommodations at any time, however, ODA notices of accommodation should be provided as early as possible in the semester to avoid any delay in implementation. Note that students must obtain a new letter of accommodation for every semester and must meet with each faculty member prior to implementation in each class. For additional information see the [ODA website](#).

Prohibition of Discrimination, Harassment, and Retaliation (Policy 16.004)

The University of North Texas (UNT) prohibits discrimination and harassment because of race, color, national origin, religion, sex, sexual orientation, gender identity, gender expression, age, disability, genetic information, veteran status, or any other characteristic protected under applicable federal or state law in its application and admission processes; educational programs and activities; employment policies, procedures, and processes; and university facilities. The University takes active measures to prevent such conduct and investigates and takes remedial action when appropriate.

Retention of Student Records

Student records pertaining to this course are maintained in a secure location by the instructor of record. All records such as exams, answer sheets (with keys), and written papers submitted during the duration of the course are kept for at least one calendar year after course completion. Course work completed via the Canvas online system, including grading information and comments, is also stored in a safe electronic environment for one year. Students have the right to view their individual record; however, information about student's records will not be divulged to other individuals without proper written consent. Students are encouraged to review the Public Information Policy and the Family Educational Rights and Privacy Act (FERPA) laws and the University's policy. See UNT Policy 10.10, Records Management and Retention for additional information.

Acceptable Student Behavior

Student behavior that interferes with an instructor's ability to conduct a class or other students' opportunity to learn is unacceptable and disruptive and will not be tolerated in any instructional forum at UNT. Students engaging in unacceptable behavior will be directed to leave the classroom and the instructor may refer the student to the Dean of Students to consider whether the student's conduct violated the Code of Student Conduct. The University's expectations for

student conduct apply to all instructional forums, including University and electronic classroom, labs, discussion groups, field trips, etc. Visit UNT's [Code of Student Conduct](#) to learn more.

Access to Information - Eagle Connect

Students' access point for business and academic services at UNT is located at: my.unt.edu. All official communication from the University will be delivered to a student's Eagle Connect account. For more information, please visit the website that explains Eagle Connect and how to forward email: [Eagle Connect](#).

Student Evaluation Administration Dates

Student feedback is important and an essential part of participation in this course. The student evaluation of instruction is a requirement for all organized classes at UNT. The survey will be made available during weeks 13, 14 and 15 of the long semesters to provide students with an opportunity to evaluate how this course is taught. Students will receive an email from "UNT SPOT Course Evaluations via IASystem Notification" (no-reply@iasystem.org) with the survey link. Students should look for the email in their UNT email inbox. Simply click on the link and complete the survey. Once students complete the survey they will receive a confirmation email that the survey has been submitted. For additional information, please visit the [SPOT website](#) or email spot@unt.edu.

Survivor Advocacy

UNT is committed to providing a safe learning environment free of all forms of sexual misconduct. Federal laws and UNT policies prohibit discrimination on the basis of sex as well as sexual misconduct. If you or someone you know is experiencing sexual harassment, relationship violence, stalking and/or sexual assault, there are campus resources available to provide support and assistance. The Survivor Advocates can be reached at SurvivorAdvocate@unt.edu or by calling the Dean of Students Office at 940-5652648.

Important Notice for F-1 Students taking Distance Education Courses

Federal Regulation

To read detailed Immigration and Customs Enforcement regulations for F-1 students taking online courses, please go to the [Electronic Code of Federal Regulations website](#). The specific portion concerning distance education courses is located at Title 8 CFR 214.2 Paragraph (f)(6)(i)(G).

The paragraph reads:

(G) For F-1 students enrolled in classes for credit or classroom hours, no more than the equivalent of one class or three credits per session, term, semester, trimester, or quarter may be counted toward the full course of study requirement if the class is taken on-line or through distance education and does not require the student's physical attendance for classes, examination

or other purposes integral to completion of the class. An on-line or distance education course is a course that is offered principally through the use of television, audio, or computer transmission including open broadcast, closed circuit, cable, microwave, or satellite, audio conferencing, or computer conferencing. If the F-1 student's course of study is in a language study program, no on-line or distance education classes may be considered to count toward a student's full course of study requirement.

University of North Texas Compliance

To comply with immigration regulations, an F-1 visa holder within the United States may need to engage in an on-campus experiential component for this course. This component (which must be approved in advance by the instructor) can include activities such as taking an on-campus exam, participating in an on-campus lecture or lab activity, or other on-campus experience integral to the completion of this course.

If such an on-campus activity is required, it is the student's responsibility to do the following:

- 1) Submit a written request to the instructor for an on-campus experiential component within one week of the start of the course.
- 2) Ensure that the activity on campus takes place and the instructor documents it in writing with a notice sent to the International Student and Scholar Services Office. ISSS has a form available that you may use for this purpose.

Because the decision may have serious immigration consequences, if an F-1 student is unsure about his or her need to participate in an on-campus experiential component for this course, s/he should contact the UNT International Student and Scholar Services Office (telephone 940-565-2195 or email internationaladvising@unt.edu) to get clarification before the one-week deadline.

Student Verification

UNT takes measures to protect the integrity of educational credentials awarded to students enrolled in distance education courses by verifying student identity, protecting student privacy, and notifying students of any special meeting times/locations or additional charges associated with student identity verification in distance education courses.

See [UNT Policy 07-002 Student Identity Verification, Privacy, and Notification and Distance Education Courses](#).

Use of Student Work

A student owns the copyright for all work (e.g. software, photographs, reports, presentations, and email postings) he or she creates within a class and the University is not entitled to use any student work without the student's permission unless all of the following criteria are met:

- The work is used only once.
- The work is not used in its entirety.

- Use of the work does not affect any potential profits from the work.
- The student is not identified.
- The work is identified as student work.

If the use of the work does not meet all of the above criteria, then the University office or department using the work must obtain the student's written permission.

Download the UNT System Permission, Waiver and Release Form

Transmission and Recording of Student Images in Electronically-Delivered Courses

- 1) No permission is needed from a student for his or her image or voice to be transmitted live via videoconference or streaming media, but all students should be informed when courses are to be conducted using either method of delivery.
- 2) In the event an instructor records student presentations, he or she must obtain permission from the student using a signed release in order to use the recording for future classes in accordance with the Use of Student-Created Work guidelines above.
- 3) Instructors who video-record their class lectures with the intention of re-using some or all of recordings for future class offerings must notify students on the course syllabus if students' images may appear on video. Instructors are also advised to provide accommodation for students who do not wish to appear in class recordings.

Example: This course employs lecture capture technology to record class sessions. Students may occasionally appear on video. The lecture recordings will be available to you for study purposes and may also be reused in future course offerings.

No notification is needed if only audio and slide capture is used or if the video only records the instructor's image. However, the instructor is encouraged to let students know the recordings will be available to them for study purposes.

Academic Support & Student Services

Student Support Services

Mental Health

UNT provides mental health resources to students to help ensure there are numerous outlets to turn to that wholeheartedly care for and are there for students in need, regardless of the nature of an issue or its severity. Listed below are several resources on campus that can support your academic success and mental well-being:

- [Student Health and Wellness Center](#)
- [Counseling and Testing Services](#)
- [UNT Care Team](#)
- [UNT Psychiatric Services](#)

- [Individual Counseling](#)

Chosen Names

A chosen name is a name that a person goes by that may or may not match their legal name. If you have a chosen name that is different from your legal name and would like that to be used in class, please let the instructor know. Below is a list of resources for updating your chosen name at UNT.

- [UNT Records](#)
- [UNT ID Card](#)
- [UNT Email Address](#)
- [Legal Name](#)

**UNT eUIDs cannot be changed at this time. The collaborating offices are working on a process to make this option accessible to UNT community members.*

Pronouns

Pronouns (she/her, they/them, he/him, etc.) are a public way for people to address you, much like your name, and can be shared with a name when making an introduction, both virtually and in-person. Just as we ask and don't assume someone's name, we should also ask and not assume someone's pronouns.

Below is a list of additional resources regarding pronouns and their usage:

- [What are pronouns and why are they important?](#)
- [How do I use pronouns?](#)
- [How do I share my pronouns?](#)
- [How do I ask for another person's pronouns?](#)
- [How do I correct myself or others when the wrong pronoun is used?](#)

Additional Student Support Services

- [Registrar](#)
- [Financial Aid](#)
- [Student Legal Services](#)
- [Career Center](#)
- [Multicultural Center](#)
- [Counseling and Testing Services](#)
- [Pride Alliance](#)
- [UNT Food Pantry](#)

Academic Support Services

- [Academic Resource Center](#)
- [Academic Success Center](#)

- [UNT Libraries](#)
- [Writing Lab](#)