ECE445M Embedded and Real-Time Systems Lab, Spring 2023
ECE380L.12 Real-time Operating Systems Lab, Spring 2023
Credit for both ECE445M and ECE380L.12 will not be allowed. Graduate students should register for ECE380L.12 and undergraduates should register for ECE445M.

Class: Tuesday/Thursday 12:30-2:00pm, ECJ 1.312
Unique Numbers (445M/380L.12):
17335/17600: MW 1:30-3:00pm, EER 1.806
17340/17605: TTh 2:00-3:30pm, EER 1.806
17345/17610: TTh 6:30-8:00pm, EER 1.806
17350/17615: MW 6:30-8:00pm, EER 1.806

Instructor:
Andreas Gerstlauer, EER 5.882, (512) 232-8294, gerstl@ece.utexas.edu
http://www.ece.utexas.edu/~gerstl
Office hours: TBD

TAs:
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Noah Rose <noah.rose@utexas.edu>
Office hours: TBD

Mailing list (all TAs and professor): s23_ece445m@utlists.utexas.edu

Class web page (lecture notes and lab assignments):
http://www.ece.utexas.edu/~gerstl/ece44m_s23/
Data sheets: http://www.ece.utexas.edu/~valvano/Datasheets/
Starter files: http://www.ece.utexas.edu/~valvano/arm/

Course Catalog Description:
Real-time operating systems; implementation of context switching, threads, multitasking, real-time scheduling, synchronization, communication, storage, file systems, memory management, process linking and loading, hardware interfacing, and networking; debugging and testing; operating system performance, including latency, jitter, deadlines, deadlocks, and starvation; real-time systems, including data acquisition, sensing, actuating, digital control, signal processing, and robotics.

Prerequisites:
ECE306 (or EE306) or ECE306H (or EE306H); ECE312 (or EE312) or ECE312H (or EE312H); and ECE319K (or EE319K) or ECE319H (or EE319H) with a grade of at least C- in each.

This class assumes prior knowledge with microcontroller laboratories. We expect you to have experiences with assembly language, serial ports (UART and SPI), periodic interrupts, ADCs, edge-triggered interrupts, FIFO queues and C programming. We will be using the same ARM Cortex-M used (since Fall 2013) in ECE319K and ECE445L, but we do not require prior experiences with the same microcontroller. You are also expected to understand how a DFT is used to observe digitally sampled data in the frequency domain.

Text: Embedded Systems: Real-Time Operating Systems for ARM Cortex-M Microcontrollers, Volume 3, Fifth Edition, January 2019, ISBN 978-1466468863, by Jonathan Valvano. Available on Amazon.

Additional reference materials:

- uC/OS-III: The Real-time Kernel for Texas Instruments Stellaris, by Jean J. Labrosse. This is a nice book (available in electronic format or from Amazon). It covers general OS topics, explains the use of uC/OS-III (a minimal but complete RTOS), and includes details of the ARM Cortex-M3 specifically on a Texas Instrument Stellaris LM3S board (not our board, but similar). There is also a second edition uC/OS-II that covers an earlier, simpler and generic OS not tied to a specific board (available on Amazon). The 3rd edition is nicely written, but specific to uC/OS-III and the given board.
- Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau, Operating Systems: Three Easy Pieces (free online version available at http://www.ostep.org/)
- Thomas Anderson and Michael Dahlin, Operating Systems: Principles and Practice, ISBN 978-0-9856735-2-9
- For programming in C, see the ECE312 text, or the Embedded Software in C online reference by Jon Valvano and Ramesh Yerraballi.
- ECE445L textbook by Jon Valvano, Embedded Systems: Real-Time Interfacing to ARM Cortex M Microcontrollers, Volume 2, Eight Edition, 2021, ISBN: 978-1463590154.
- Data sheets for most of the devices used in this class are available at http://www.ece.utexas.edu/~valvano/Datasheets

Development boards:

1. We will use the TI EK-TM4C123GXL LaunchPad. Each team of students must buy/borrow one LaunchPad, but we strongly suggest that each student purchase their own board to work independently. We have been using the TM4C123 board in EE319K since Fall 2013, so you might be able to find one used. If you do purchase a used board, ask a TA or me to run the board tester to make sure it works. If it still works at the end of the semester, you will be able to sell this board to students in later classes. Otherwise, the easiest way to purchase the LaunchPad is from the TI.com E-store or any of the buying options listed on Octopart.com.
2. In addition to the LaunchPad, we will provide a sensor board to each student or team. The LaunchPad plugs into the sensor board to access additional peripherals, such as a display, SD card and Wifi module, as well as various sensors for the robot. We will hand out sensor boards at the beginning of the semester. You will need to return them at the end of the semester.

Other equipment and parts:

1. You will need a Sitronix ST7735R 18-bit color 1.8" TFT LCD display with a MicroSD slot and the exact breakout provided by Adafruit (Adafruit Part 358). You can purchase a display yourself, e.g. by checking the buying options on Octopart.com. However, this will require soldering to attach the header. Alternatively, we can provide you with a soldered display together with the sensor board that you will need to both return at the end of the class.
2. You will also need an ESP8266 Wifi module. Those can be purchased for a few dollars on the internet. If you buy one yourself, try to get the ESP-01 module, not the newer ESP-01S. The ESP-01S requires a pin to be cut to work with our sensor board. Alternatively, we can also lend you an ESP-01.

3. We will provide all other components and parts to assemble your final robot, including the mechanical platform as well as an additional motor board next to the sensor board into which you will plug your LaunchPads. All robot components provided by us will need to be returned at the end of the semester. You will, however, be allowed to upgrade your robot with additional sensors, circuitry and parts (except motors and battery, and within a limited budget).
4. A digital logic analyzer will be needed to optimize and debug your OS. Logic analyzers are available in the lab. We will also provide a software solution that uses the TM4C itself to collect logic traces and allow you to work outside of the lab. However, you may want to invest into a simple PC-based USB logic analyzer, which will be more flexible and useful for other projects. There are many options out there, including high-end and versatile ones (e.g. Digilent's Analog/Digital Discovery) that can be an investment for the future. For this class, we will not need very high sampling rates, so an analyzer starting at $20 will suffice, e.g. Sparkfun 24Mhz/8-Channel USB Logic Analyzer.
5. You will need own your own digital multimeter to build and debug your robot. You must be able to measure voltage and resistance, so a meter costing around $20 will suffice.
6. Places to buy parts in Austin:
    - AlTex Electronics
    - Frys Electronics
    - Radio Shack
7. Full service online sales:
    - Digikey, http://www.digikey.com/
    - Mouser Electronics, http://www.mouser.com/
    - Newark, http://www.newark.com/
    - Sparkfun, http://www.sparkfun.com/
    - Jameco, http://www.jameco.com/
    - Arrow, http://parts.arrow.com/
8. Surplus sales:
    - BG Micro, http://www.bgmicro.com/
    - All Electronics, http://www.allelectronics.com/

Software:
We will use the 32k limited version of Keil uVision, Version 5.x, available for download at https://www.keil.com/demo/eval/arm.htm. Information about the compiler/debugger system is at http://www.keil.com/uvision/. All necessary starter code and a large number of software examples for the board will be available by installing Prof. Valvano's starter files and board support package. To complete the labs, it will take time outside of the 3 scheduled lab hours. It will be important for you to configure a development system on your laptop (Keil version 5.x and PuTTy). This way you will be mobile and flexible about where and when you work on lab.

Course Outcomes:
The purpose of ECE445M/ECE380L.12 is to provide students an in depth understanding of real-time operating systems, real-time debugging, and embedded systems. After the successful conclusion of ECE445M/ECE380L.12, students should be able to design real-time embedded systems, such as motor controllers, data store systems, data acquisition systems, communication systems and robotic systems.

Specific Objectives of ECE445M/ECE380L.12:
The primary objective of ECE445M/ECE380L.12 is for students to develop the ability to design real-time systems. This class allows students to combine principles of microcomputer interfacing, software development, digital logic and analog circuits into the design of microcomputer-based systems:

1. *ARM architecture, and C programming*
   Minimally intrusive debugging
   Performance measures
2. *Synchronization methods*
   Busy-wait, interrupt, DMA, periodic polling, priority interrupts
3. *Embedded Communication Systems*
   Serial network protocols, layered software, CAN, Ethernet, and USB
4. *Real time operating systems*
   Foreground and background thread scheduling
   Synchronization using spinlock and blocking semaphores
   Interthread communication
5. *Digital Device Interfaces*
   SD drive interface using SPI, file systems
   Diodes, transistors, DC motors, servos, stepper motors, relays, solenoids,
   Optical sensors, IR distance sensors and contact switch sensors
6. *Time Domain Interfaces*
   Input capture/output compare, frequency, period and pulse width measurements,
   Pulse-width modulation
7. *Data Acquisition Systems*
   Op amp amplifiers, analog low pass filters, ADC, FIFO queues, digital filters
8. *Control systems*
   Open loop and closed loop, Linear and Nonlinear,
   Bang-bang control, incremental control, PID Control

Teaching philosophy
I strongly encourage students to take an active role in class. There will be a copious amount of action in this class: debugging, soldering, screwing, cutting, and testing. Questions are welcome before, during and after class. Please feel free to email, visit or call me if you have questions.

Grading
50% Laboratory
25% Midterm, Thursday**,** March 2, 2023, 12:30pm-2:00pm, in class (tentative)
25% Final, Friday, April 28, 2023, 3:30pm-5:30pm, TBD (regularly scheduled)
Please notice the dates for the exams; there will be no re-tests, make-ups, or incompletes.
Attendance: Class attendance will be used for deciding grades in borderline cases. Students are expected to attend all lectures. Fundamental material will be presented in class, and the details can be found in the book, the data sheets and the library files provided by the manufacturer. Some lecture material will be posted on the web, while other material will only be presented in class. If you decide that you do not want to come to every lecture, please drop this class.
ECE380L.12 Grading:
80% Regular ECE445M grade
20% Project
ECE380L.12 Project: Graduate students will attend the lectures, take the exams, and perform the labs. In addition to all the regular ECE445M assignments, they will perform an extra lab project

involving the design, implementation and testing of an embedded system with a real-time operating system. The complexity of this project should be equivalent to one of the regular labs. The project should be approved in advance by the instructor (come see me to discuss project ideas or if you want to brainstorm potential projects). A 1/2 page written proposal concerning the project is due by the end of February. The project must be demonstrated to the instructor or a TA, and a project report is due to the instructor the first Monday after classes are over. You are free to choose a project in your field of interest. It must include an embedded system and a real-time operating system of your design. You must write microcomputer software and/or build microcomputer hardware. It must actually be built and tested. The report will be typed double spaced. The minimum page count is 15 and the maximum page count is 20 (including hardware diagrams, but not software listings.) The grading policy for the report has four parts:

25% English style, grammar, spelling, clarity of discussion, logical organization
25% Neatness and presentation, figures, diagrams, graphs
25% Engineering quality, originality, creativity, correctness
25% Evaluation and test procedures, how do you verify its correctness.

Special note to undergraduate students taking ECE380L.12 as their gateway grad course into the integrated BS/MS program: I strongly recommend you create a project that highlights your creativity and analytic skills. The grad admissions committee is interested in your scientific and intellectual and not your engineering skills. So create a project with conceptual theory and critical analysis so that the admissions committee will know you will succeed in grad school.

Lab Partners: All labs up to and including Lab 5 should be performed with a partner (teams of 2). Labs 6 and 7 will be performed in teams of 3 to 5 students. The lab partnerships must be registered with your TA at least a week before the assignment is due. Once registered, the partnership will continue. A partnership can be dissolved only after discussion with the TA. All partners must be present during the demonstration. It is expected that both partners will contribute to all aspects of each lab, and all partners are expected to be present during the check out. The point values are the same for all labs. The TA will sign your software listing when you demonstrate your system. All parts of the assignment must be demonstrated to a TA by the end of your lab period the week the "Demo/Report" is due. Any ECE345M/ECE380L TA is authorized to checkout your lab. The report (hardware, software, data and plots) are due one day after the demonstration is due. Please consult with your TA for specific due dates for your lab section.

ECE445M/ECE380L Laboratories

1. Real-time clock, Sitronix ST7735R Display, ADC and graphics drivers on the TM4C123 board running on an ARM Cortex-M4 (review of ECE445L)
2. Real-time operating system kernel (thread switching and synchronization)
   Part 1) is cooperative and preemptive schedule
   Part 2) has periodic and switch interrupts, and spin-lock semaphores
3. Blocking semaphores, priority scheduling, performance measures, RTOS profiling
4. Solid state disk, SSI, address translation, layered software, file system
5. Memory management, process loader, process creation and linking
6. Robot interfaces, networking, distributed sensor data acquisition, motor PWM (teams of 3, 4 or 5)
7. Formula 0001 Racing Robot (teams of 3, 4 or 5)
   A. Moving and turning, basic control algorithm
   B. Autonomous operation, system performance analysis (pre-qualification)
   C. Race competition (qualifying & finals)

Lab Schedule (tentative)

Week	1st session	2nd session	Friday 5pm	Comments
1/9	No activites	Meet the TA		Lab equipment demo
1/16	-	Lab 1 Prep		
1/23	Lab 1 Demo	Lab 2.1 Prep	Lab 1 Report	
1/30	Lab 2.1 Demo	Lab 2.2 Prep		Lab 2.1 has no report
2/6		Lab 2.2 Demo	Lab 2.2 Report	
2/13	Lab 3 Prep			
2/20	Lab 3 Demo		Lab 3 Report	Hard deadline on Lab 3. If Lab 3 is not demonstrated, revert and complete rest with Lab 2 OS.
2/27	Lab 4 Prep			**Midterm is 3/2 (tentative)**
3/6	Lab 4 Demo	Lab 5 Prep	Lab 4 Report	
3/13	*Spring Break*			
3/20	Lab 5 Demo	Lab 6 Prep	Lab 5 Report	
3/27	Lab 6 Demo	Lab 7.A Prep	Lab 6 Report	
4/3		Lab 7.A Demo		
4/10		Lab 7.B Demo		
4/17	Lab 7.C Demo	Lab 7.C Demo	Lab 7 Report	Turn in equipment by 4/24

Prep = you turn in your lab preparation
Demo = you demonstrate your lab to the TA
Report = you turn in your complete lab report (online)
During the week of January 9-13, please go to your scheduled lab sessions to get a demonstration of the lab equipment. Lab partners will be selected in your lab the weeks of January 9-13 and January 17-20.

The lab preparations (syntax error-free software source code and documentation) are due at the beginning of your lab period. In other words, please type your software into the PC before the lab. Attendance in lab is required. All software for lab, and tests must include comments. Students are encouraged to go to the last 1 hour of the other lab periods, but the first priority will be to the regular students. During the first 15 minutes of lab, the TA will collect preparations. For the next 15 minutes, the TA will lead a lab discussion session. The remaining lab time is available for debugging and lab checkout.

At the end of the semester, verify with the instructor and checkout counter that your record is clear and you have returned all equipment or a bar will be put on your registration for next semester. All reports must be given to the TA by Monday, April 24, 5pm to be considered for grading.

Lecture Schedule (tentative)

Week	Book	Topic
1 (1/9)	1, 2.1-2.5, 2.10, 2.12	Course introduction, ARM architecture, instruction set, stack, uVision4 compiler, quality software, device drivers, GPIO, timer, UART, ADC, interrupts, modular programming, call & data flow graphs, debugging techniques, lab environment, intrusiveness
2 (1/16)	4.1-4.2	RTOS, multi-threading/-tasking, OS architecture, interrupt servicing, operating modes, context switching
3 (1/23)	4.3-4.6	Threads, TCB, cooperative multitasking, round-robin scheduler

		Thread communication & synchronization, critical sections, reentrance, FIFO, mailbox
4 (1/30)	5 2.11	Spinlock & blocking semaphores, monitors, deadlocks, process networks Debugging, testing, path expressions, performance measures (response time, jitter, throughput)
5 (2/6)	6	Real-time scheduling, priority scheduler, scheduling anomalies, fixed-rate scheduler
6 (2/13)	2.6, 3 8	SD and flash disk interface using SSI, high-speed interfacing, DMA File system, file and disk management
7 (2/20)	7	Memory management, heap, processes, process management, process images, loading linking, relocation, PCBs
8 (2/27)	**1-6**	**Midterm, Thursday, 3/2**, in class, covering material in Labs 1-3
9 (3/6)	2.7, 10 2.8, 11.2	Sensor interfacing, input capture, period measurements, signal processing, Motor interfacing, transistor interfaces, pulse width modulation (PWM)
(3/13)		*Spring Break*
10 (3/20)	9.1-9.4	Microcontroller networking, Controller area network (CAN), Ethernet Internet, protocol stacks, ISO/OSI model, TCP/IP, IoT
11 (3/27)	11	Robots, team work, testing & debugging, design process, Control systems, PID control systems, fuzzy logic and control, odometry
12 (4/3)	Arpaci-Dusseau Anderson/Dahlin	Memory and process management (cont'd), memory protection, virtual memory, paging
13 (4/10)	12 1-11	Commercial RTOS, uC/OS, VxWorks Final exam review
14 (4/17)		**Robot competitions (preliminary and final), EER Atrium.** All lab reports are due Monday, April 24, 5pm. Turn in lab equipment by Friday so we won't bar your registration.
Finals (4/24)	**1-11**	**Final exam, Friday, 4/28, 3:30-5:30pm**, TBD (regularly scheduled)

Legal Notes:
The 12th class day is January 25, 2023. The drop policy is extremely complicated. See your academic advisor or the Dean of Students for more information. Course evaluation is conducted on the last class day in accordance with the Measurement and Evaluation Center form. The final exam is at the time and place stated in the course schedule. March 21 is the last day an undergraduate student may, with the Dean's approval, withdraw from the University or drop a class except for urgent and substantiated, nonacademic reasons.

Electronic mail notification policy: In this course, e-mail will be used as a means of communication with students. You will be responsible for checking your e-mail regularly for class work and announcements. The complete text of the University electronic mail notification policy and instructions for updating your e-mail address are available at http://cio.utexas.edu/policies/university-electronic-mail-student-notification-policy.

Use of Canvas and class web site: This course uses the class web page and Canvas to distribute course materials, to communicate and collaborate online, to submit assignments and to post solutions and grades. You will be responsible for checking the class web page and the Canvas course site regularly for class work and announcements. As with all computer systems, there are occasional scheduled downtimes as well as unanticipated disruptions. Notification of disruptions will be posted on the Canvas login page. Scheduled downtimes are not an excuse for late work. However, if there is an unscheduled downtime for a significant period of time, we will make an adjustment if it occurs close to the due date.

Sharing of course materials: Sharing of course materials is prohibited. No materials used in this class, including, but not limited to, lecture hand-outs, videos, assessments (quizzes, exams, papers, projects, homework assignments), in-class materials, review sheets, and additional problem sets, may be shared online or with anyone outside of the class unless you have my explicit, written permission. Unauthorized sharing of materials promotes cheating. It is a violation of the University's Student Honor Code and an act of academic dishonesty. I am well aware of the sites used for sharing materials, and any materials found online that are associated with you, or any suspected unauthorized sharing of materials, will be reported to Student Conduct and Academic Integrity in the Office of the Dean of Students. These reports can result in sanctions, including failure in the course.

Class recordings: Class recordings are reserved only for students in this class for educational purposes and are protected under FERPA. The recordings should not be shared outside the class in any form. Violation of this restriction by a student could lead to Student Misconduct proceedings.

Students with disabilities: The University of Texas at Austin provides upon request appropriate academic adjustments for qualified students with disabilities. Students with disabilities may request appropriate academic accommodations from the Division of Diversity and Community Engagement. For more information, contact Disability and Access (D&A), Student Services Building (SSB), 471-6259, http://diversity.utexas.edu/disability/.

Religious Holy Days: By UT Austin policy, you must notify the instructor of your pending absence at least fourteen days prior to the date of observance of a religious holy day. If you must miss a class, an examination, a work assignment, or a project in order to observe a religious holy day, we will give you an opportunity to complete the missed work within a reasonable time after the absence.

Online learning resources: This course may be offered in an online format to which you are unaccustomed. If you are looking for ideas and strategies to help you feel more comfortable participating in our class, please explore the resources available here: https://onestop.utexas.edu/keep-learning/.

Sanger Learning Center: More than one-third of undergraduates use the Sanger Learning Center each year to improve their academic performance. All students are welcome to join their classes and workshops and make appointments for their private learning specialists, peer academic coaches, and tutors.

UT Outpost: UT Outpost is equipped with a food pantry, and a career clothing closet to ensure every Longhorn has access to professional clothes for job and internship interviews. Emergencies and financial hardships can interfere with student success beyond the classroom, and this program will serve as an additional resource for students.

Counseling and mental health: Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs and alcohol, getting enough sleep and taking some time to relax. This will help you achieve your goals and cope with stress. All of us benefit from support during times of struggle. You are not alone. There are many helpful resources available on campus and an important part of the college experience is learning how to ask for help. Asking for support sooner rather than later is often helpful. If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support. The Counseling and Mental Health Center (CMHC) provides counseling, psychiatric, consultation, and prevention services that facilitate students' academic and life goals and enhance their personal growth and well-being: http://cmhc.utexas.edu/. You can also talk to the CARE Counselor in the College of Engineering, who can be reached at 512-471-8396 and has drop-in office hours in EER 2.848.

Title IX reporting: Title IX is a federal law that protects against sex and gender-based discrimination, sexual harassment, sexual assault, sexual misconduct, dating/domestic violence and stalking at federally funded educational institutions. UT Austin is committed to fostering a learning and working environment free from discrimination in all its forms where all students, faculty, and staff can learn, work, and thrive. When sexual misconduct occurs in our community, the university can:

1. Intervene to prevent harmful behavior from continuing or escalating.
2. Provide support and remedies to students and employees who have experienced harm or have become involved in a Title IX investigation.
3. Investigate and discipline violations of the university's relevant policies.

Faculty members and certain staff members are considered ``Responsible Employees" or ``Mandatory Reporters," which means that they are required to report violations of Title IX to the Title IX Coordinator at UT Austin. The instructors (myself and the TAs) are Responsible Employees and must report any Title IX related incidents that are disclosed in writing, discussion, or one-on-one. Before talking with me, the TAs, or any faculty or staff member about a Title IX related incident, be sure to ask whether they are a responsible employee. If you want to speak with someone for support or remedies without making an official report to the university, email advocate@austin.utexas.edu. For more info about reporting options and resources, visit https://titleix.utexas.edu/campus-resources or contact the university's Title IX Office via email at titleix@austin.utexas.edu.

Classroom evacuation and emergency preparedness: All occupants of university buildings are required to evacuate a building when a fire alarm and/or an official announcement is made indicating a potentially dangerous situation within the building. Familiarize yourself with all exit doors of each classroom and building you may occupy. Remember that the nearest exit door may not be the one you used when entering the building. If you require assistance in evacuation, inform your instructor in writing during the first week of class. For evacuation in your classroom or building:

1. Follow the instructions of faculty and teaching staff.
2. Exit in an orderly fashion and assemble outside.
3. Do not re-enter a building unless given instructions by emergency personnel.

Emergency evacuation route information and emergency procedures can be found at http://www.utexas.edu/emergency and http://preparedness.utexas.edu/.

COVID-19 Guidance: While we will post information related to the contemporary situation on campus, you are encouraged to stay up-to-date on the latest news at https://protect.utexas.edu/.

To help preserve our in-person learning environment, the university recommends the following to help protect yourself, your friends and family, as well as the community (especially those who can not protect themselves, e.g. children who can not be vaccinated) in Austin in general:

- Vaccinations are widely available, free and not billed to health insurance. The vaccine will help reduce the transmission of the virus to others and reduce serious symptoms in those who are vaccinated.
- Adhere to university guidances as well as CDC guidelines and City of Austin guidelines regarding masking and protecting yourself and others. In particular, properly fitted and high-quality (K)N95 masks can significantly reduce transmission especially indoors and in large crowds (e.g. in class).
- Proactive Community Testing remains an important part of the university's efforts to protect our community. Tests are fast and free.

To help keep everyone at UT and in our community safe, it is critical that students report COVID-19 symptoms and testing to University Health Services, and faculty and staff report to the HealthPoint Occupational Health Program (OHP) as soon as possible. To help understand what to do if a fellow student in the class (or the instructor or TA) tests positive for COVID, see this University Health Services link.

Scholastic Dishonesty

"Faculty in the ECE Department are committed to detecting and responding to all instances of scholastic dishonesty and will pursue cases of scholastic dishonesty in accordance with university policy. Scholastic dishonesty, in all its forms, is a blight on our entire academic community. All parties in our community -- faculty, staff, and students -- are responsible for creating an environment that educates outstanding engineers, and this goal entails excellence in technical skills, self-giving citizenry, an ethical integrity. Industry wants engineers who are competent and fully trustworthy, and both qualities must be developed day by day throughout an entire lifetime. Scholastic dishonesty includes, but is not limited to, cheating, plagiarism, collusion, falsifying academic records, or any act designed to give an unfair academic advantage to the student. The fact that you are in this class as an engineering student is testament to your abilities. Penalties for scholastic dishonesty are severe and can include, but are not limited to, a written reprimand, a zero on the assignment/exam, re-taking the exam in question, an F in the course, or expulsion from the University. Don't jeopardize your career by an act of scholastic dishonesty. Details about academic integrity and what constitutes scholastic dishonesty can be found at the website for the UT Dean of Students Office and the General Information Catalog, Section 11-802."

You are encouraged to study together and to discuss information and concepts with other students. You can give or receive "consulting" help in oral form. However, this permissible cooperation should never involve one student having possession of a copy of all or part of work done by someone else, in the form of an email, an email attachment file, a portable storage device, or a hard copy. Copying of any part of a program is cheating without explicit reference to its source. We do enter lab assignments turned in by other students through a plagiarism checker, comparing them to assignments of this and previous semesters. If we find two programs that are copied, there will be a substantial penalty to both students, e.g., failure in the course. Students who cheat on tests or in lab will fail. Prosecution of cases is very traumatic to both the student and instructor. It is appropriate to use software out of the book, class website as long as all copy-pasted software is explicitly referenced. Copy-pasting software from current or past students is scholastic dishonesty. Policies concerning the use of other people's software in this class:

- I strongly encourage you to study existing software.
- All applications and libraries must be legally obtained. E.g.,
    - You may use libraries that came when you bought a compiler.
    - You may use software obtained from the web.
    - You may copy and paste from the existing source code.
- You may use any existing source code that is clearly referenced and categorized:
    original: completely written by you,
    derived: fundamental approach is copied but it is your implementation,
    modified: source code significantly edited to serve your purpose,
    copied: source code includes minor modifications.

University Honor Code: "The core values of the University of Texas at Austin are learning, discovery, freedom, leadership, individual opportunity, and responsibility. Each member of the University is expected to uphold these values through integrity, honesty, trust, fairness, and respect toward peers and community." (see the university catalog).