Programming Hardware/Software Systems

Course Information

Instructor: Linda Wills (linda.wills@ece.gatech.edu)
Course Prefix and Number: ECE 2035 A
Units: 4 credits (3-3-4)
Term: Fall 2026

General Course Information

Description

This course presents execution and storage mechanisms used to support high level programming languages and operating systems. This design-oriented course describes how complex mechanisms are created using operations and storage defined in an instruction set architecture. Assembly language examples illustrate key course concepts. Lecture material is reinforced by design projects that require C programming and RISC-V assembly language programming, focusing on performance and storage resource requirements on hardware platforms.

Course goals: The learning objectives of this course are to:

- Understand how execution and storage constructs in high-level programming languages and operating systems are implemented on a hardware platform.
- Learn design principles for sequential, procedural programming, the C programming language and RISC-V assembly language, and the use of common tools for software development and performance evaluation.
- Build experience in systems-oriented design, focusing on performance and storage requirements of the target application and hardware platform.

Course Learning Outcomes

Upon completion of this course, you should be able to:

- Develop a software design using appropriate data and procedural abstractions given an engineering problem specification.
- Implement high-level programming language storage, control, and procedural constructs in the assembly language of a hardware platform.

- Use commonly available tools for software development, system management, debugging, performance monitoring, and optimization.
- Develop a software system that uses multiple files and libraries.
- Develop, test, and deploy reliable software using appropriate operating system capabilities (e.g., file and directory access, I/O interface).

Required Course Materials

- **TEXTBOOK: Patt and Patel, *Introduction to Computing Systems*,** 3rd edition, 2019. (2nd edition is fine, too.)
- **ERNIE RISC-V Emulator and Debugger** for running assembly language programs in VS Code. (FREE)
- **Linux**: Remote access to ECE Linux servers. (FREE)
- **ESP classroom kit** – Classroom kit consists of two packages (each student needs both):
    - **ESP-32-C6/uLCD/Parts Loaner Kit**: available for checkout at the Georgia Tech library for 120 days, which will cover the entire semester. To do this, visit the INFO Desk on the ground floor of Price Gilbert (hours: https://library.gatech.edu/hours). *The kits have been made possible by the ECE Cares program to help reduce the cost to students.*
    - **Breadboard & Wire kit**: available from Eta Kappa Nu (2nd week of classes only), Sparkfun, DigiKey, and others. If previously purchased for ECE 2031, those should be sufficient.

Grading Policy:

The final grades are determined based on totals earned during the course.

Assessment	Description	Percentage of total grade:
Exams (3)	In-class midterm exams	30%
Homework (3)	Programming assignments	10%
Projects (2)	Major programming assignments	30%
Final Exam	In-class final exam	25%
Participation	Attendance and online Canvas assignments	5%

Grades are assigned as follows (assuming a passing project average): [90-100] = A, [80-90) = B, [70-80) = C, [60-70) = D, [0-60) = F.

Description of Graded Components

CLASS PARTICIPATION: Participation credit is earned by completing attendance checks (see policies below) as well as completing practice exercises, lecture comprehension quizzes, and any other in-class activities that may be assigned.

ASSIGNMENTS: Multiple homework assignments and projects are assigned throughout the semester. Homework is assigned more frequently, while projects have longer timeframes and are weighted more heavily. All homework assignments and projects are to be completed and submitted individually *with no collaboration or interaction with others* (except TAs and the instructor).

MIDTERM EXAMS: There are three 50-minute midterm exams each given during the lecture class period in the normal classroom. They are closed-book, closed-notes exams. Calculators and other electronic devices *are not* allowed on the exams. Each exam focuses on the material covered since the last exam. However, due to the cumulative nature of the material, all exams are comprehensive (i.e., they may draw on all material covered in the class thus far.) Each midterm exam contributes 10% of the overall grade.

FINAL EXAM: The final exam covers all material covered in the class. It is closed-book, closed-notes. Calculators and other electronic devices *are not* allowed. The final exam contributes 25% of the overall grade.

Grading concerns should first be directed to the person grading the assignment (e.g., the GTA or UTA for homework & project grades, the instructor for exams, participation, etc.), but any unresolved issue can be addressed to the instructor as needed. Also, it is expected that any grading concerns be raised within one week of the grade being posted, because it isn't possible to address a large number of issues in the last weeks of the semester. Exam regrades are processed entirely within Gradescope and within the period of time specified there, possibly less than a week.

Course Policies

Attendance and/or Participation

Students must create a Point Solutions account at the echo360 site if they do not already have one. They must be able to access it in class on their smart phone and/or computer. Students can check their attendance record at any time, and they are responsible for checking before leaving class, making it clear that they were present at that time.

Academic Integrity

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. Students should review Georgia Tech's Honor Code and the student Code of Conduct.

Any student suspected of cheating or plagiarism on a quiz, exam, or assignment will be reported to the Office of Student Integrity, who will investigate the incident and identify the appropriate penalty for violations. Suspected violations of academic integrity may be handled through Faculty Conference Resolution, or students may have their case heard directly by the Office of Student Integrity.

Although students are encouraged to work together to learn the course material, graded class work must be completed individually. Specifically, while they are permitted to discuss the homework and project assignments and algorithms with other students in the class, **they must design, write, and debug their solutions individually. They must not accept/copy/solicit code from, share code with, debug code, or discuss its performance with any AI assistant or any person, except the instructors/TAs. Once they begin implementing their solution, they must work alone. They must not share any code, homework solution or any graded work before or after the due date. Students are responsible for understanding all of the detailed explanation of this policy at a page on the course Canvas site: *Academic Integrity Specifics for ECE2035*.**

Additionally, all code and course materials provided in ECE2035 are copyrighted. They are for the use of the students currently enrolled in the course. Copyrighted course materials may not be further disseminated. Students may not, nor knowingly allow others to reproduce or distribute code or other course materials publicly. This includes providing materials to commercial course material suppliers such as CourseHero, Chegg, and other similar services, or posting assignment code on Github. Students who publicly distribute or display or help others publicly distribute or display copies or modified copies of ECE2035's course materials are in violation of Georgia Tech's Honor Code.

All exams are to be completed individually with no collaboration or interaction with anyone else. Students may neither give nor receive unauthorized assistance on any exam. They may not work with others on the exam and may not share questions or answers with anyone else, including looking for or posting questions/answers online.

Accommodations for Students with Disabilities

Students with learning needs that require special accommodation should contact the Office of Disability Services (404-894-2563) as soon as possible to make an appointment to discuss their special needs and to obtain an accommodations letter. When the

instructor is notified of the student status, the instructor will assign a brief questionnaire to fill out on Canvas, which should provide all needed information. The student should contact the instructor if they believe there are additional items to discuss regarding their learning needs. Also, note that accommodations are given as they arise. As an exam approaches, for example, students who utilize the Testing Center must request accommodations according to their requirements. Merely having discussed accommodations at the start of the semester is not sufficient.

Student-Faculty Expectations Agreement

At Georgia Tech, we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. The Student-Faculty Expectations articulate some basic expectations that faculty and students have for each other. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Students are encouraged to remain committed to the ideals of Georgia Tech while in this class.

Prerequisites

ECE 2020. It is imperative that you be very familiar with

- the concept of a datapath,
- the major components of a datapath,
- memory, and especially RAM, and
- the specifics of a single-cycle datapath, such as that of the RISC-V processor.

That last point is particularly relevant to transfer students or anyone substituting a different prerequisite, since ECE 2020 specifically covers the single-cycle datapath. We will immediately begin with review of the single-cycle datapath and go into more detail about the RISC-V instruction set architecture (ISA).

Extra Credit Opportunities

On both project assignments, it is possible to earn as much as 25% extra credit, based on exceeding the baseline requirements.

Exam Replacement: If a student's score on the final exam is greater than their lowest midterm exam grade, it will be used to replace the lowest midterm exam score. It cannot replace a zero that results from either an unexcused absence or an Honor Code violation.

Collaboration, Group Work, and Use of Generative AI

See the Academic Integrity section above and note the reference to "AI assistant or any person."

Extensions, Late Assignments, & Re-Scheduled/Missed Exams

The Canvas page for each homework and project assignment specifies the late policy. In general, for all assignments, *except parts of* Project 2, the assignment may be submitted up to 5 days after the posted due date, with a 10% per day late penalty.

Students should not hesitate to contact the instructor if extenuating circumstances arise. Staying in contact is critical. Students who are struggling or falling behind can make an appointment to discuss how to proceed.

Missed Exam policy: Exams are taken at the scheduled class time or at the scheduled final period. A missed exam will be recorded as a zero. Family emergencies and extreme medical emergencies are handled in a manner appropriate to the situation, which may be an excused absence allowing the Exam Replacement policy above to be in effect.

Inclement Weather and Digital Learning Days

In the event of a campus closure due to inclement weather, lectures will be delivered remotely, in accordance with Georgia Tech policies that were revised in August 2023. Refer to the Campus Procedures for Hazardous Weather.

Backing up Work

It is each student's responsibility to create backups of work performed in this class. Lost work or time due to computer/disk/web server failures is not a valid excuse for late submissions.

Campus Resources for Students

A list of resources for undergraduate students' academic success and information about advising can be found at Success at Tech.

Student Well-Being:

At Georgia Tech, we are concerned about your overall physical, social, and mental well-being. A comprehensive list of wellness related resources has been compiled and maintained by the Office of the Vice President for Student Engagement and Well-being.