TEXAS A&M UNIVERSITY

PRELIMINARY SYLLABUS

Course Information

Course title and number:	ECEN 350: Computer Architecture and Design		
	Sections: 513 - 518		
Term:	Fall 2020		
Meeting times:	Lecture	8:00 am – 8:50 am	MWF
Location	Remote/Virtual via Zoom		
	Credit Hours: 4		

Instructor Details

Instructor: Dr. Oscar Moreira-Tamayo

Office: WERC 244-F (via Zoom this semester)

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Office Hours: Monday and Wednesday, 2:00PM–3:00PM via Zoom or by email arranged time.

Zoom Meeting for office hours: https://tamu.zoom.us/j/2743546199

Meeting ID: 274 354 6199

Course Description

Computer architecture and design; use of register transfer languages and simulation tools to describe and simulate computer operation; central processing unit organization, microprogramming, input/output and memory system architectures. Cross-listed with CSCE 350.

Course Prerequisites

ECEN 248 - Introduction to Digital Systems

Textbooks and Required Materials

Required Book:

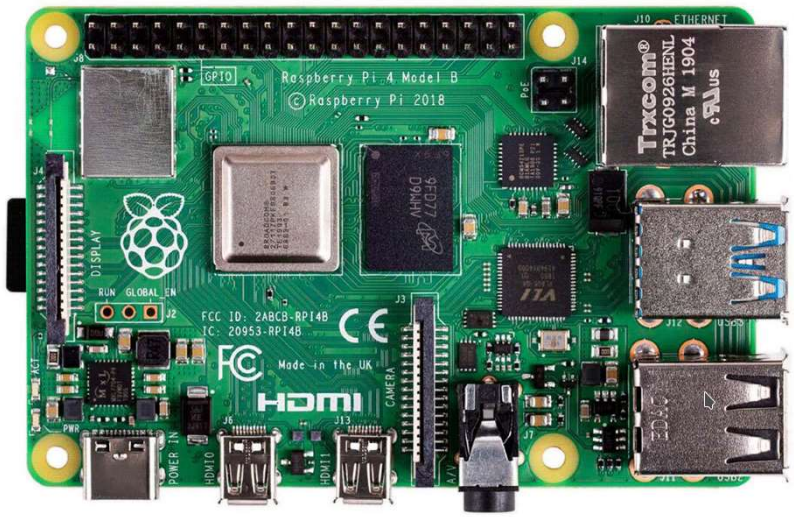
- David Patterson and John Hennessy, "Computer Organization and Design: The hardware/software interface", ARM EDITION, 2016 or newer. Electronic versions are OK. (**note: it must be the "ARM" edition, no other edition is usable for this class**)

Required Equipment:

The following equipment is required prior to attending the first 350 lab during the second week of class:

Raspberry PI 4 B single board computer (https://www.raspberrypi.org/products/raspberry-pi-4-model-b/) - Each student must purchase one PI 4 B board. Costs ~$35 from the link to the right.

Note: Do not buy a PI Zero or PI 2 or 1 board, they may not support the needed ARMv8 ISA. (more details in the Lab01 description).



The following equipment is also required. You may already have some of these things, if so there is no reason to purchase them again:

- 16GB or larger Micro SD Card - Each student must have at least one 16GB Micro SD Card. On Amazon these go for as low as $5. Note that higher performance cards will improve boot time and performance of the R-Pi system. **See the raspberry pi website for more details on Micro SD card requirements. (https://www.raspberrypi.org/documentation/installation/sd-cards.md)**
- USB-C DC power adapter - The R-Pi board requires a USB-C DC power source. Generally, most USB-C phone chargers will work (>=15W). If you don't have one handy and need to purchase one, **this one should work (https://www.amazon.com/Adapter-Raspberry-Version-Supply-Charger/dp/B0851D1CSJ/)** .
- Micro SD Card Reader - You will need this to burn the image onto the SD card, any micro SD card reader should work, many computers have them built in. **If you do not have one this one should work. (https://www.amazon.com/SmartQ-C307-Portable-MicroSDHC-MicroSDXC/dp/B06ZYXR7DL/)**
- **Micro HDMI to HDMI connector (https://www.amazon.com/gp/product/B07VXDLB5N/)** - needed to convert the micro HDMI port on the board to standard HDMI for a TV/monitor (you will need this if you plan to attend lab "in-person" or if you plan to use your Pi in a "desktop" mode at home).

Optional Equipment:

If you wish to turn your R-Pi board into a full "desktop" computer at home you will need the following additional equipment.

- HDMI Cable - connect from converter to the TV/monitor, any HDMI cable should work.
- USB Keyboard and Mouse - to provide input, any USB keyboard/mouse should work.
- HDMI TV or external monitor - to see the full GUI. Pretty much any modern TV should work, or up to a 4K external monitor.

Course Learning Outcomes

The goal of this course is to provide the student with a working knowledge of different methods for logic representation, manipulation, and optimization, for both combinational and sequential logic. At the end of the course the student should be able to view the design of digital systems from a new perspective and have an understanding of several fundamental concepts that can be applied to a wide variety of digital design problems.

Individual Course Objectives:

At the end of this course, students should:

- Understand the organization of a computer system including the CPU datapath, CPU control, and memory systems
- Understand the impact of semiconductor technology on computer design and architecture.
- Understand the basics and principles of instruction set design.
- Be familiar with programming using an assembly level language.
- Understand the impact of instruction sets on hardware design.
- Be familiar with designing data paths for a processor.
- Understand the implications of branch instructions on program flow and hardware design.
- Understand the performance implications of various factors such as clock speed, average clock cycles per instruction and number of instructions.
- Understand the role of compilers and high-level languages in programming.
- Be familiar with designing control circuitry for a basic processor.
- Understand the differences in single-cycle/multicycle design of processors.
- Be familiar with processor pipelining.
- Understand the implications of pipelining on memory design, instruction set design, compiling, performance etc.
- Understand the implications of branch instructions on pipelining.
- Understand basics of memory technology, registers, SRAM, DRAM.
- Understand the performance issue of various memory technologies.
- Be familiar with the notion of locality.
- Understand the memory architectures including cache architectures.
- Be familiar with various cache architectures: direct-mapped, set-associative, wide/narrow block size etc.
- Understand the concepts of virtual memory.
- Be familiar with the need for address translation.
- Understand the impact of address translation on cache/memory accesses.
- Be familiar with hardware designs of various cache architectures.
- Understand the basics of Input/Output.
- Understand the principles of instruction-level parallelism (ILP) and processor microarchitectures which exploit it.
- Understand the principles of thread-level parallelisms and processor microarchitecture which exploit it.
- Understand register-transfer level (RTL) system concepts and description methods, including a hardware description language (VERILOG)

Grading Policy

The final grade will be determined using the following scheme:

- Two partial exams 20% (10% each)
- Final Exam 20% (Comprehensive)
- Laboratory 35%
    - Includes Pre-Lab, Lab Reports and Lab Quiz(zes)
- Quizzes 15%
- Class Participation and Attendance 10%

Note: If the average overall grade of all students lies below a 79% there will be a curve on the overall grade.
Grading Scale (out of 100): A: 90-100; B: 80-89; C: 70-79; D: 60-69; F: 59 or lower

Assignments/Quizzes:

Rather than traditional homework, this course will rely upon a series of on-line quiz assessments. The goal of these quizzes will be to test your knowledge of the lecture material and pinpoint which lectures you should go back and review on-line. There will be one quiz for each lecture, this quiz must be completed prior to the next lecture. Students may retake the quiz as many times as desired between its release and the next lecture, however no late quizzes will be accepted.
The TAMU Canvas system will be used for all quiz submissions

Labs:

The course will have nine prelabs and nine labs. Prelabs are expected to be completed before attending the associated lab session. Late prelabs will have 50% of the points deducted for being one working day late, more than 2 days late will not be accepted. Generally, post-labs and demos must be completed the week following the lab's introduction (the exception being a couple labs that take two weeks). Late post-labs will have 20% of the points deducted for being late up to 1-week. If a post-lab and/or demo is late for more than a week then, a grade of 0 will be assigned.
Note: all students are required to purchase a Raspberry Pi board prior to Lab1, as noted above.

Lectures, attendance and participation:

All lectures will be delivered synchronously via Zoom during the normal class period. The lectures will also be recorded live during the lecture class period. The recordings will be uploaded to the TAMU Canvas website for on-line viewing and review. All students are expected to be active participants during lecture, and their Lecture Participation grade will be based on pop questions during class. If the pop question(s) is not answered timely no credit will be given for the corresponding lecture attendance.

Outline & Preliminary Schedule (Subject to change)

WEEK	DATE	TOPIC
1	Aug 19 – Aug 22	Overview of Computer Architecture
2	Aug 23 – Aug 29	Instruction Set Architectures (ISA), Representing instructions on the computer, Arithmetical and logical instructions, Memory access instructions
3	Aug 30 – Sep 5	Instruction Set Architectures (ISA), Control flow instructions, Function calls instructions, Input- output instructions SPIM- instruction set simulator
4	Sep 6 – Sep 12	Computer Arithmetic, Signed and unsigned numbers, Addition and subtraction, Multiplication, Division, Floating point operations
5	Sep 13 – Sep 19	Translating and starting a program, Compilers, compiler optimization, Object code generation, assemblers, linking, Run-time execution environment
6	Sep 20 – Sep 26	Performance evaluation, CPU performance and its factors, performance metrics, performance factors, comparing performance, SPEC benchmarks
7	Sep 27 – Oct 3	Hardware Description Languages, Verilog hardware description language, Design-Simulation Process,
8	Oct 4 – Oct 10	Structural Designs in Verilog Behavioral HDL Description of Systems Datapath and Control, and ALU design
9	Oct 11 – Oct 17	Single-cycle implementation
10	Oct 18 – Oct 24	Microprogramming, catchup
11	Oct 25 – Oct 31	Pipelining
12	Nov 1 – Nov 7	Pipelined datapath, Pipelined control
13	Nov 8 – Nov 14	Pipeline hazards: structural, control, data hazard detection and resolution, exception handling Memory Hierarchy, Overview of SRAM and DRAM design
14	Nov 15 – Nov 21	Basic of caches, Framework for memory hierarchy, Measuring memory performance
15	Nov 22 – Nov 24	Course review
	TBA	Final Exam

Remarks

- **Canvas.**
  - Class notes and handouts will be posted on **OneNote.**

Attendance.

- The policy for attendance and excused absences is according to the university rules: https://student-rules.tamu.edu/rule07/.
- Attendance to class is required in order to do the in-class problems and quizzes. **If you miss class you should email me, preferably before class is over and tell me the circumstances. This does not guarantee makeup work is possible, but is required if there is to be makeup.**
- Please also notice that according to the university rules:
  - The student is responsible for providing satisfactory evidence to the instructor to substantiate the reason for absence
  - Except in the case of the observance of a religious holiday, to be excused the student must notify his or her instructor in writing (acknowledged e-mail message is acceptable) prior to the date of absence if such notification is feasible.
  - If needed, the student must provide additional documentation substantiating the reason for the absence, that is satisfactory to the instructor, within one week of the last date of the absence.
  - If an instructor has a regularly scheduled make up exam, students are expected to attend unless they have a university approved excuse. The make-up work must be completed in a timeframe not to exceed 30 calendar days from the last day of the initial absence.

Academic Integrity

- "An Aggie does not lie, cheat, or steal, or tolerate those who do."
- For additional information please visit: http://www.tamu.edu/aggiehonor
- The handouts used in this course are copyrighted. The definition of "handouts" is all materials generated for this class, which include but are not limited to syllabi, homework assignments, in-class materials, and additional printed materials except published scientific papers for personal use. Because these materials are copyrighted, you do not have the right to make additional copies of the handouts unless the instructor of this course expressly grants permission.
- As commonly defined, plagiarism consists of passing off the ideas, words, writings, etc., of another as one's own. In accordance with this definition, you are committing plagiarism if you copy the work of another person without proper citation and acknowledgement, and turn it in as your own, even if you should have the permission of that person. Plagiarism is one of the worst academic offenses, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated. Paraphrasing without proper citation and

acknowledgement is one form of plagiarism. If you have any questions regarding plagiarism, please consult the latest issue of the Texas A&M University Student Rules, under the section "Scholastic Dishonesty". Any forms of dishonesty including, but not limited to, cheating on any examinations and plagiarism will be handled according to the procedures outlined by the Aggie Honor System Office. Please check the following websites for further information:

- University Regulations Student Handbook: http://student-rules.tamu.edu
- Definition of Academic Misconducts: http://www.tamu.edu/aggiehonor/acadmisconduct.htm

Americans with Disabilities Act (ADA) Policy Statement:

- The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities, in Room 126 of the Koldus Building or call 845-1637.