Department of Electrical and Computer Engineering

The University of Texas at Austin

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Course Outline

January 20, 2021

January 20: Lecture 1: Intro to the course. Levels of Transformations. Basic architectural choices. Science of Tradeoffs.

January 21,22: First Discussion Session. Bookkeeping, overview, expectations, PL0, Intro/Focus

> Programming Lab 0 is due, Sunday night, January 24, 11:59pm. (The program itself will be empty. The purpose of the assignment is to make sure we are on the same page re: using the system.)

January 25: Lecture 2: Intro/focus, continued. Tradeoffs, Latency and Bandwidth, Role of Parallelism, Role of Speculation, Overview of Quantitative Insights, Role of the Architect, Alternative Design Points.

January 27: Lecture 3: Intro to Instruction Set Architecture, with examples taken from many diverse ISAs. Difference between ISA and Microarchitecture, ISA tradeoffs. Detailed discussion of LC-3b, with Assembly language constructs. The Assembler, how it works.

January 28,29: Discussion Session. The ISA, Assembly Process, PL1.

> Problem set 1 due before class, February 1. (Emphasis: ISA, the Assembly Process.)

February 1: Lecture 4: Microarchitecture, LC-3b data path, state machine, microsequencer, two-level microprogramming, Wilkes' Diode Matrix, Choice of ASICs, FPGAS, EMT instruction for enhanced performance

February 3: Lecture 5: Microarchitecture, continued. Microarchitecture Tradeoffs, Enhancing Performance. Pipelining, and its implications. Scoreboarding and its limitations.

February 4,5: Discussion Session. Microarchitecture of the LC-3b, PL1.

> Programming Lab 1 is due, Sunday night, February 7, 11:59pm. Write a program (Program A) in LC-3b assembly language to solve a problem. Write an assembler to translate LC-3b assembly language code into the instructions in the LC-3b ISA. Assemble Program A with the Assembler you wrote.

February 8: Lecture 6: Microarchitecture, continued. (Out of order Execution, The Tomasulo Algorithm why it did not work, and how we fixed it).

February 10, Lecture 7: Branch Prediction and other performance enhancements.

February 11,12: Discussion session: Pipelining, Scoreboard, Tomasulo, Branch Prediction, PL2.

> Programming Lab 2 is due, Sunday night, February 14, 11:59pm. (Write a program in C that simulates at the instruction cycle level the baseline LC-3b ISA. Test your simulator with the output of the assembler for the application program written in Programming Lab 1.)

February 15: Lecture 8: Canceled

February 17, Lecture 9. Canceled

February 18,19: Discussion session: Canceled

February 22, Lecture 10: Canceled

February 24, Lecture 11: Branch Prediction and other performance enhancements.

February 25,26: Discussion session: Pipelining, Scoreboard, Tomasulo, Branch Prediction, Lab 3.

> Problem set 2 due before class, March 1. (Emphasis: uarch the LC-3b, the Assembly Process, Pipelining, Tomasulo, Branch Prediction.)

March 1: Lecture 12: Physical Memory. SRAM, DRAM, NVM. Interleaving, Unaligned accesses.

March 3, Lecture 13. Physical Memory, continued.

March 5,6: Discussion Session. Physical Memory, Lab3, Prepare for first midterm.

> Programming Lab 3 is due, Sunday night March 7, 11:59pm.
> (Finish the clock-cycle level Simulator for the LC-3b.
> Test it on the application program written in Programming Lab 1.)

March 8, Lecture 14: The notion of Process, interaction with the O/S, Exceptions and Interrupts.

March 10: Lecture 15: Exam 1

March 11,12: Discussion Session. Go over the exam

March 15,19: Spring break.

March 22, Lecture 16: Virtual memory, page tables, TLB, VAX model, IA32 model, Translation and Protection, contrast with segmentation.

March 24, Lecture 17: Virtual Memory, continued.

March 25,26: Discussion Session. Virtual memory

March 29, Lecture 18: Virtual Memory, continued.

March 31: Lecture 19: Cache memory.

April 1,2: Discussion session: Virtual Memory, Cache Memory, PL4

Problem set 3 due before class, April 5. (Physical Memory, Virtual Memory)

April 5, Lecture 20: Cache memory, continued.

April 7, Lecture 21: Input/Output. Asynchronous/Synchronous, Arbitration, Transaction.

April 8,9: Discussion session: Cache Memory, I/O, PL4.

Programming Lab 4 is due, Sunday night April 11, 11:59pm.
Interrupts/Exceptions

April 12: Lecture 22: Integer Arithmetic (Long integers, BCD, Kogge-Stone adders, Boothe's Algorithm, Residue Arithmetic)

April 14: Lecture 23: Floating point Arithmetic (Instruction formats, Gradual underflow, Rounding modes, NaNs, Floating Point Exceptions)

April 15,16: Discussion Session: Integer Arithmetic, Floating point arithmetic, Prepare for Exam 2.

Problem set 4 due before class, April 19. (Emphasis on Cache, I/O)

April 19: Lecture 24: Single-thread parallelism. SIMD, Vectors, VLIW vs Wide Issue, DAE.

April 21: Lecture 25: Exam 2.

April 22,23: Discussion Session: Go over Exam 2. PL5.

Programming Lab 5 is due, Sunday night April 25, 11:59pm.
(Virtual memory)

April 26: Lecture 26: Single-thread parallelism, continued. (HPS, Data Flow).

April 28: Lecture 27: Intro to Multiprocessing, Amdahl's Law, Speed-up, efficiency, Interconnection networks, Cache Coherency, Memory Consistency.

April 29,30: Discussion Session. Single Thread Parallelism, Multithread Processing,

Problem set 5 due before class, May 3. (Emphasis on Arithmetic)

May 3: Lecture 28: Multithread parallelism (continued)

May 5: Lecture 29: Last class, free for all!

May 6,7: Discussion session. Review of the course, Prepare for Final exam.

Programming Lab 6 is due, Friday afternoon, May 7, 5pm.

Problem set 6. To be used as part of your study guide for the final exam, not to be turned in. (Emphasis on single thread parallelism and multiprocessing, but also a little on out-of-order, physical, virtual, and cache memory, arithmetic, I/O)

Final exam: Probably Friday, May 14, 7-10pm.

Please note: The Registrar has the right to change the dates of the final exams. Please keep checking the Registrar's web site and our announcements to be sure when the final exam will be given.