

Department of Electrical and Computer Engineering  
The University of Texas at Austin

EE 306, Fall, 2023

Yale Patt, Instructor

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Course Outline (Syllabus)

August 21, 2023

August 21: Lecture 1. Overview of EE 306, Levels of Transformation

- The computer -- a complex system organized in levels of interpretation.
- The computer -- a universal computational device; given enough time and space it can do anything any other computational device does.

August 23: Lecture 2: Chapter 2: Bits and operations on bits.

- The bit as a unit of information.
- Encoding of bits: Binary numbers (integer data type, ASCII codes
- Negative numbers, 2's complement representation, sign-extension.
- Overflow
- Floating point data type (Normalized numbers, Subnormal, infinities, NaNs)
- hex representation of binary numbers.
- Arithmetic operations on numbers. ADD, SUB. [Note that  $x+x$  = left shift]
- Logical variables
- Logical (Bit-wise) operations on bits. AND, OR, NOT, XOR
- DeMorgan's Laws

August 24,25: Discussion Session. Orientation to our computing environment, email, tools, other logistics

August 28: Lecture 3. Bits and operations on bits (continued).

August 30: Lecture 4. Chapter 2 (continued).

Discussion Session. Emphasis on Chapter 2, problem set 1.

September 4: Labor Day, no class

**Problem set 1, due before class, September 6.**

September 6: Lecture 5. Chapter 3: Basic Logic Structures

- The transistor as a switch
- Basic Gates (AND, OR, NOT)
- Truth table representations
- Any arbitrary function can be built out of these gates (no attempt at minimization. Just an awareness exercise)
- full ADDER, MUX, DECODER

September 7,8: Discussion Session. Emphasis on Chapter 3, Problem set 2

September 11: Lecture 6. Storage structures, Memory and Finite State Machines

- Basic storage element (Gated RS latch)
- A register
- a logic circuit to implement a small piece of memory (perhaps  $2^{*}2 \times 3$ )
- concept of memory: address space, addressability

- The notion of state (one of the most important concepts in engineering)
- State diagram, Next State table, State Assignment
- Implementation example: sequential machine

September 13: Lecture 7. Finite State Machines (continued).

September 14,15: Discussion Session. Emphasis on Chapter 3, problem set 2

**Problem set 2, due before class, September 18.**

September 18: Lecture 8. Chapter 4: Introduction to Von Neumann model and the LC-3 ISA.

- the basic structure of the Von Neumann model, showing the basic flow.
- instruction = opcode, operands
- encoding of instructions and data
- instruction cycle (Fetch, Decode, EA, Fetch data, Execute, Store result)
- organization of memory
- address space, addressability revisited (MAR, MDR)
- instruction formats
- operate, data movement, and control instructions
- LD/ST (also, indirects)
- control (condition codes: N,Z,P)
- The datapath necessary to implement the LC-3
- I/O via the TRAP instruction [Keyboard in, screen out]

September 20: Lecture 9. Chapter 5, the LC-3 ISA, A sophisticated LC-3 program

- a detailed example in machine language
- example will use keyboard for data input, monitor for data output

September 21, 22: Discussion Session: Chapter 4,5, The Simulator/Debugger, PL0,1

**Programming Lab 0 due, 11:59pm, September 22.**

September 25: No class

September 27: Lecture 10. The LC-3, the data path and state machine

September 28,29: Discussion Session, Emphasis on Chapter 5 and PL1

**Programming Lab 1 due, 11:59pm, October 1.**

October 2, Lecture 11. Chapter 6: Structured Programming and Debugging

- Elements of Problem Solving (stepwise refinement, systematic decomposition, etc.)
- Fundamentals of Debugging (setting breakpoints, single-step, deposit, examine, etc.)
- the control structure of a stored program (sequential, conditional, iteration)

October 4: Lecture 12. Chapter 7: Moving up a level, Assembly Language and the Assembler.

- going from higher to lower level: interpretation vs. translation
- translation: what do assemblers and compilers do?
- hand assemble programs from earlier lectures.
- revisiting the character count problem

October 5,6: Discussion Session: Prepare for Midterm exam.

**Problem set 3, due before class, October 9.**

October 9: Lecture 13. Review or catch up!

October 11: Lecture 14. **Exam 1.** Chapters 1-7

October 12,13: Discussion Session: Go over exam, discuss Programming Lab 2.

October 16: Lecture 15. Detailed Microarchitecture of the LC-3 (Appendix C)

October 18: Lecture 16. Chapter 8: Subroutines. JSR/RET

-- saving/restoring state

-- success/failure mechanisms

October 19,20: Discussion Session: Emphasis on Appendix C, Subroutines, PL2

**Programming Lab 2 due, 11:59pm, October 22.**

October 23: Lecture 17. Stacks

**NOTE: Oct 23 is the last day to drop a course without special permission, and to change grading to pass/fail.**

October 25: Lecture 18. Queues, Linked Lists, Character Strings

-- tradeoffs between sequential allocation and linked lists for sorted information

October 26,27: Discussion Session: Problem set 4, Programming Lab 3

**Problem set 4, due before class, October 30.**

October 30: Lecture 19. Recursion.

November 1: Lecture 20. Chapter 9: Physical I/O

-- asynchronous activity

-- memory mapped vs. special I/O instructions

-- program control vs. device (interrupt) driven

-- device registers (KBDR, KBSR, DDR, DSR)

-- Synchronization via the ready bit.

-- interrupt enable bit

-- I/O Service Routines

November 2,3: Discussion Session: Recursion, I/O, Emphasis on Programming Lab 3

**Programming Lab 3 due, 11:59pm, November 5.**

November 6: Lecture 21. Chapter 9: Physical I/O (continued).

**Problem set 5, due before class, November 8.**

November 8: Lecture 22. Review or Catch up.

November 9,10: Discussion Session: Prepare for Midterm 2, Programming Lab 4

November 13: Lecture 23. **Exam 2.**

November 15: Lecture 24. Traps and Interrupts

November 16,17: Discussion Session: Go over Exam 2, Emphasis on Programming Lab 4

**Programming Lab 4 due Friday, Nov 18, before leaving for Thanksgiving recess.**

November 20 to 25: No class, Thanksgiving Recess. Enjoy the Holiday!

November 27: Lecture 25. Chapter 9 (continued) TRAPs, Interrupts, Exceptions

November 29: Lecture 26. Chapter 10: Chapter 10 The Calculator, life after 306

-- ASCII/2's-complement conversion

-- Stack arithmetic

-- The Calculator, itself

-- Parallelism. The latest hot button!

December 2,3: Discussion Session: Traps, Interrupts, Programming Lab 5

**Programming Lab 5 due, December 4, 11:59pm**

December 4: Lecture 27. Last lecture. Free-for-all. Any OTHER questions!

**Problem set 6, not to be handed in, use for final exam preparation.**

December 8. **Likely date of the Final Exam**, 7 to 10pm.

(Note: the Registrar may change the date of the final exam at his discretion. Please do not make plans to leave campus for the semester break until after the date of our final exam is confirmed by the Registrar's office.

### **Programming Labs:**

0th programming Lab Due September 22, 11:59pm.

1st programming Lab (machine language) -- Due: October 1, 11:59pm.

2nd programming Lab (assembly language) -- Due: October 22, 11:59pm.

3rd programming Lab (assembly language) -- Due: November 5, 11:59pm.

4th programming Lab (assembly language) -- Due: November 18, 11:59pm.

5th programming Lab (assembly language) -- Due: December 4, 11:59pm

### **Problem Sets:**

1st problem set, (emphasis on Chapters 1,2). Due: just before class, September 6

2nd problem set, (emphasis on Chapter 2,3). Due: just before class, September 18

3rd problem set, (emphasis on Chapter 1-6). Due: just before class, October 9. (Note: exam on October 13)

4th problem set, (emphasis on Chapter 7,8). Due: just before class, October 30.

5th problem set, (emphasis on Chapters 8,9). Due: just before class, Nov 8. (Note: exam on Nov 13)

6th problem set, (emphasis on Chapter 9,10). Not to be turned in.