Problem 1. We saw that certain functions, such as parentheses checking, cannot be performed by any finite state machine. Which of the following can be performed by an FSM? Assume, in each case, that the device is to take a series of 0s and 1s that represent the digits of a binary number entered left-to-right. The device is to have a single output, which is 1 only under the specified conditions:

A. When the last 277 digits entered have been alternate 1s and 0s.
B. When more 0s than 1s have been entered.
C. When the number entered thus far is divisible by 3.
D. When an odd number of 1s and and even number of 0s have been entered.
E. When the number entered corresponds to a year in which the Red Sox win the world series.

Problem 2.

A. Ben Bitdiddle's proposed Ph.D. thesis involves writing a program to compute a function f(x) on a Cray supercomputer. Ben's advisor points out that f cannot be computed on any Turing machine. Should Ben care? Why?
B. Discouraged by your answer to the last question, Ben has turned his attention to an alternative thesis topic. He now proposes to invent the universal FSM, which will be to FSMs what a universal Turing machine is to Turing machines. Ben's idea is to build an FSM that can fed a sequence of inputs describing any other FSM and the inputs to that FSM. The universal FSM would then emulate the behavior of the described FSM on the specified inputs. Is Ben's idea workable? Why or why not?

Problem 3.

A. What are the four most important components of the von Neumann machine? Draw their correlations.
B. What are the four most important components of a CPU?
C. How much memory can a 32-bit von Neumann machine have? Why?
D. Can a CPU have as many registers as possible, in theory?