Due at the start of class Monday, November 10, 2003.

Problem 1. The *median-1* function takes as input a_0, a_1, a_2, and a_3, where an odd number of the a_i are guaranteed to be 1, and produces a two digit output $b_1 b_0$ giving the index of the middle 1. So, for example, 1000 has output 00, 0001 has output 11, and 1011 has output 10. If there are not an odd number of 1's, the output is undefined and can be anything.

(a) Give the truth table for median-1 function (for four inputs).

(b) Use part (a) to produce Boolean formula for median-1 using minterms in the straightforward way.

(c) Use part (b) to produce a circuit for median-1 in the straightforward way. You may use gates with more than two inputs. The circuit should have seven AND and OR gates in total.

(d) Produce a circuit for median-1 using fewer AND and OR gates. Try to use as few as possible.

Problem 2.

(a) Show how 2×1 multiplexers can be used to implement an AND gate.

(b) Show how 2×1 multiplexers can be used to implement an OR gate.

(c) Assume you have 0 and 1 available on two wires called `zero` and `one`. Show how 2×1 multiplexers can be used to implement a NOT gate.

(d) What do we learn from this problem?

Problem 3. Assume you build an $n \times 1$ multiplexer using two-input AND and OR gates, where n is a power of 2. Assume you have available each input and its complement.

(a) How many gates do you need? Justify your answer.

(b) How many levels of gate delay does the circuit take? Justify your answer.