Practice midterm exam

ECE 203

Initially given on 3 May 2004

Prepared by Robert Dick

You may not use books, notes, or calculators when completing this exam.

Show your work.

Please look over all the problems now and ask questions if any of them are not clear.

(3 pts., 2 min.) Means the problem is worth 3 points and should not require more than 2 minutes to complete.

Good luck!

1. **(5 pts., 2 min.)** Show the schematic of (design) a two-input OR gate built from NMOS and PMOS transistors.
2. Encoder (6 min.)
   (a) **(5 pts., 3 min.)** Design a two-input encoder (i_1, i_0), (o) using only NAND, NOR, and NOT (inverter) gates. Exactly one input will be active at a time. The output value should be the binary number associated with the active input. Take advantage of don't-cares; efficiency counts.
   (b) **(5 pts., 3 min.)** Starting from two four-input encoders and whichever additional logic gates are convenient, design an efficient eight-input encoder.
3. Minimization (12 min.)
   (a) **(10 pts., 4 min.)** Use a Karnaugh map to find minimal SOP expression for the following function:

$$f(a,b,c) = \prod(0,7) + DC(1,5)$$

   (b) **(9 pts., 4 min.)** Use the Quine–McCluskey algorithm to find a minimal SOP expression for the following function:

$$f(a,b,c) = \sum(2,4) + DC(1,7)$$

   (c) **(1 pts., 30 sec.)** How many literals does the expression you found in Problem 3b have?
   (d) **(5 pts., 3 min.)** Is it possible to further reduce the literal count of your expression for Problem 3b using algebraic manipulation? If so, do it and note the new literal count.

4. **(5 pts., 3 min.)** Use full-adders and 2:1 multiplexers to implement a four-bit unsigned binary carry select adder ($a_{3\cdots0}, b_{3\cdots0}$), ($o_{4\cdots0}$) with a maximum carry chain length of two full-adders. The adder is unsigned, so determining o_4 is straight-forward.

5. **(5 pts., 3 min.)** Convert -35 (decimal) to eight-bit two's-compliment binary.

6. **(5 pts., 2 min.)** Using two or fewer sentences, describe the most important property that Gray codes share.

7. **(5 pts., 2 min.)** How many additional symbols can we represent using Unicode after we have reserved space for every symbol in ASCII (the regular ASCII, which allows easy parity checking, not extended ASCII)? You needn't fully simplify your answer, i.e., it would be fine to write "$4^3 + 5^2$" instead of writing "89".

8. **(5 pts., 2 min.)** Consider a 74LS00 integrated circuit with power and ground connected correctly. Pins 1 and 2 are inputs to the first NAND gate (with output pin 3). If pin 1 is connected to V_{DD} and pin 2 is not connected to anything, will pin 3 be high, low, or high-Z?