National Chiao Tung University
Dept. of Computer & Information Science
Intro. to Digital Systems, Spring 1998

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Handout #12
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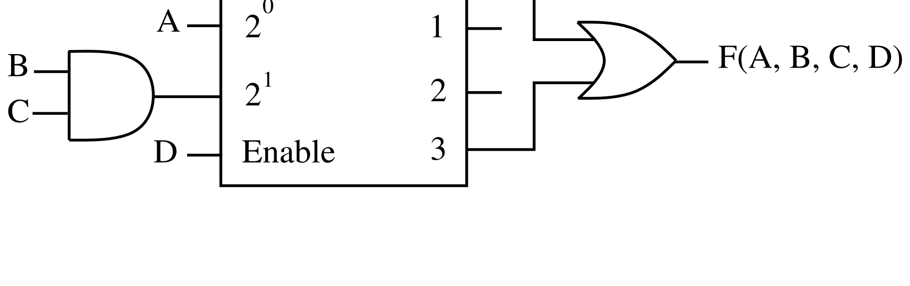
Quiz #2 (Serial Number:)

Instructions. This is a 50-minute quiz. There are five questions to be graded out of 90. Good luck!

Question 1. (16 pts total) Fill in the fields with no $\times$'s below with 8-bit binary numbers in the given signed representation. The first row has been done for you. The decimal number (-45) is a "negative forty-five." Convert the decimal numbers to the proper representations, state them as an **addition problem** in the representation, and give the correct result in each representation. If the calculation produces an overflow in any of the representations used, note it as "OVERFLOW" and omit the answer.

Problem	Sign−Magnitude	1's Complement	2's Complement
0 + 0 0	00000000 + 00000000 00000000	00000000 + 00000000 00000000	00000000 + 00000000 00000000
−120 + 45 ??		×	×
120 + 45 ??	×	×	
120 + −45 ??	×		

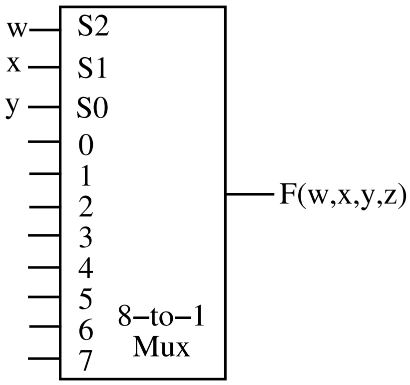
Question 2. (14 pts total) Find the corresponding Boolean function $F(A, B, C, D)$ of the following logic circuit. Give the result in **sum-of-minterms** format.



Question 3. (20 pts total) A majority function $F(w, x, y, z)$ is generated in a combinational circuit when the output is equal to 1 if the input variables w, x, y, z have more 1's than 0's. The output is 0 otherwise.

(a) (8 pts) Derive the truth table and the simplified Boolean equation for $F(w, x, y, z)$.

(b) (12 pts) Implement F with an 8-to-1 line multiplexer shown below. You may use only 0, 1, NOT, OR, and AND gates. Note that w is applied to S_2, x is applied to S_1, and y is applied to S_0.



Question 4. (20 pts total) A combinational circuits has four inputs E, x_2, x_1, x_0 and three outputs y_2, y_1, y_0. Let $X = x_2x_1x_0$ and $Y = y_2y_1y_0$ be two unsigned binary numbers such that the corresponding decimal values satisfying $0 \leq X, Y \leq 7$. The combinational circuit's function can be described as follows: If $E = 0$, then $Y = X$. Otherwise, if $E = 1$, then $Y = (X + 2)$ *modulo* 8, i.e., the remainder of $(X + 2)/8$. For example, if $X = 6$, $E = 1$, then $Y = (6 + 2)$ *modulo* $8 = 0$.

(a) (8 pts) Derive the truth table of this combinational circuit.

(b) (12 pts) Implement the combinational circuit using the minimal number of gates.

Question 5. (20 pts total) Consider a 4-bit carry lookahead adder with inputs $A = a_3a_2a_1a_0$, $B = b_3b_2b_1b_0$, c_0 and outputs $S = s_3s_2s_1s_0$ and c_4. Let $g_i = a_ib_i$ and $p_i = a_i \oplus b_i$.

(a) (12 pts) Write c_1, c_2, c_3, c_4 in terms of g_i, p_i $(i = 0, 1, 2, 3)$ and c_0.

(b) (8 pts) Let $A = 1010$ and $c_0 = 0$. If the propagate function $p_2 = 1$ and generate function $g_1 = 1$. **Find** c_4. (**Hint:** $s_i = a_i \oplus b_i \oplus c_i$ and $c_{i+1} = a_ib_i + b_ic_i + a_ic_i$.)