Cpr E 281 HW03

ELECTRICAL AND COMPUTER ENGINEERING
IOWA STATE UNIVERSITY

NAND/NOR Gates and Synthesis
Assigned Date: Third Week
Due Date: Sep. 14, 2015

P1. (10 points) Use algebraic manipulation to show that for three input variables x_1, x_2, and x_3 the following is true:

$$\sum m(1, 2, 3, 4, 5, 6, 7) = x_1 + x_2 + x_3$$

P2. (10 points) For the following two expressions, draw the truth table and express each one of them as a sum of minterms and also as a product of maxterms:

$$(XY + Z)(Y + XZ)$$

$$(\overline{A} + B)(\overline{B} + C)$$

P3. (20 points) Find the simplest SOP circuit that implements the function:

$$f(x1, x2, x3) = \Sigma m(3, 4, 6, 7)$$

Then draw the circuit diagram using only NAND gates.

P4. (20 points) Considering the truth table below, which has three inputs (X, Y, Z) and two outputs (M, N)

X	Y	Z	M	N
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

a) Write the functions M and N in short hand notation using minterms and maxterms. (5 points)

b) Write the functions M and N in canonical sum-of-products (SOP) and canonical product-of-sums (POS) forms. (5 points)

c) Obtain the simplest SOP expressions for the functions M and N and draw their respective circuit diagrams. (10 points)

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P5. (20 points) A circuit that checks for equality has one output f and four inputs x_1, x_2, y_1, y_2. Let $X=x_1 x_2$ and $Y=y_1 y_2$ represent two 2-digit binary numbers. The output f should be 1 if the numbers represented by X and Y are equal. Otherwise, f should be 0. For example, if $x_1=1$, $x_2=0$, $y_1=0$, and $y_2=1$, then the output should be zero because X=2 and Y=1 (in decimal). On the other hand, if $x_1=x_2=1$ and $y_1=y_2=1$, then the output should be 1 because the two numbers are equal.

a) Show the truth table for f. (10 points)

b) Write the canonical sum-of-products expression for the function f. (5 points)

c) Write the canonical product-of-sums expression for the function f. (5 points)

P6. (10 points) Show how to implement a NOT gate using:

a) 2-input NAND gate(s),

b) 2-input NOR gate(s)

c) 2-1 multiplexer(s).

For part (a) and part (b), you should use a different approach than simply connecting both terminals to the input signal. Note that you are allowed to connect constant voltages (i.e., logic values 0 or 1) to the gates.

P7. (10 points) Redraw the following circuit using only NAND gates: