CPE 64 PAL Worksheet ECS, CSUS

COMBINATIONAL LOGIC DESIGN WORKSHEET

1) Design a Combinational circuit with four inputs and one output. The output is 1 when the binary value of the inputs is a prime number.

2) Design a combinational circuit with three inputs, x, y, and z, and three outputs, A, B, and C . When the binary input is 0, 1, 2, or 3, the binary output is two greater than the input. When the binary input is 4, 5, 6, or 7, the binary output is one less than the input.

3) Design a four-bit Combinational circuit 1's complementor. (The output generates the 1's complement of the input binary number.)

4) Implement the following Boolean function with a 4 x 1 multiplexer and external gates. F_1 (A, B, C, D) = $\sum(0,2,5,6,8,10,12,13,15)$.
Connect inputs A and B to the selection lines. The input requirements for the four data lines will be a function of variables C and D. These values are obtained by expressing F as a function of C and D for each of the four cases when AB = 00, 01, 10, and 11. These functions may have to be implemented with external gates.

5) Realize $Z = AB' + AD + C'D' + A'C$ using only two-input NAND gates. Use as few gates as possible.

6) A simple well- known game, tic-tac-toe, is played on a three-by-three grid of squares by two players. The players alternate turns. Each player chooses a square and places a mark in a square. (One player uses X and other O.) Lets make our own rules (The first player with three marks in a row or in a column wins the game). A logic circuit is to be designed for an electronic tic- tac-toe that indicates the presence of a winning pattern. The circuit output W is a 1 if a winning pattern is present and a 0 if a winning pattern is not present. For each of the nine squares, there are two signals Xi and Oi. Two copies of the circuit are used, one for Xs and one for Os. Hint: Form a condensed truth table for W(X_1,X_2,X_3,….,X_9)

   Design the X circuit for the following pattern of signals for the squares:

$$\begin{matrix} X_1 & X_2 & X_3 \\ X_4 & X_5 & X_6 \\ X_7 & X_8 & X_9 \end{matrix}$$

   Minimize the W output for the X circuit as much as possible, using Boolean algebra.

7) Repeat the above problem for 4 x 4 tic-tac-toe, which is played on a four – by - four grid. Assume that the numbering pattern is left to right and top to bottom as in the above problem.

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8) Design a combinational circuit that accepts a 3-bit number and generates a 6-bit number output equal to the cube of the input number.

9) Design an eight input NAND gate using 2-input NAND gates.

10) Implement the Boolean function $F(A, B, C, D) = \sum m(2,4,6,9,10,11,15)$ with an 8-to-1 multiplexer.