CprE 2810 HW02
ELECTRICAL AND COMPUTER ENGINEERING
IOWA STATE UNIVERSITY

Boolean algebra, AND/OR/NOT gates
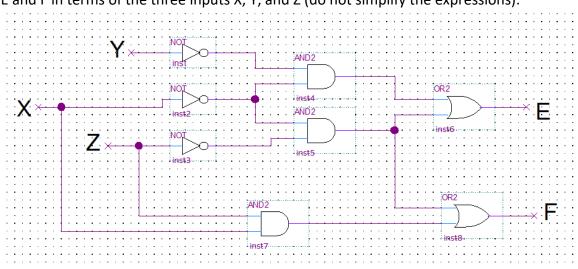**Assigned Date: Second Week**
Finish by: Sep. 9, 2024

P1. (10 points) Given the functions $f_1 = \overline{x}y + xz + yz$ and $f_2 = (B + \overline{C})(A + C)\overline{B}$

   A. Draw the truth table for each function.

   B. Draw the Venn diagram for each function.

P2. (15 points) Prove the following:

   A. $\overline{B}\overline{D}(\overline{A} + C) + \overline{B}D(\overline{A} + B) + B\overline{D}(C + D) = \overline{A}\overline{B} + C\overline{D}$ using Boolean Algebra

   B. $\overline{(W + \overline{X} + \overline{Y} + Z)(\overline{W} + X + \overline{Y} + Z)} = \overline{W}XY\overline{Z} + W\overline{X}Y\overline{Z}$ using truth tables

   C. $\overline{N}\overline{O}\overline{P} + N\overline{O}P + \overline{N}OP + N\overline{O}\overline{P} = N\overline{O} + \overline{O}P + \overline{N}OP$ using Venn diagrams

P3. (10 points) Given the circuit below, find the Boolean expressions for the two outputs E and F in terms of the three inputs X, Y, and Z (do not simplify the expressions):

P4. (15 points) Use Boolean Algebra to simplify the following expressions to a minimum-cost Sum-Of-Products formula.

   A. $x\overline{z} + \overline{x}y\overline{z} + xy + x\overline{y}z$

   B. $\overline{A}BCD + AB\overline{C}D + \overline{B}CD + A\overline{B}$

   C. $(N + O)(O + P)(\overline{N} + P)$

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P5. **(15 points)** Given the following truth table, show the following:

L	M	N	F
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	1

A. The Venn Diagram
B. The canonical Products-Of-Sums expression for F
C. The shorthand notation for the POS
D. The canonical Sum-Of-Products expression for F
E. The shorthand notation for the SOP

P6. **(25 points)** Consider the logic function $f(w, x, y, z) = \sum m(0,3,4,5,8,11,12,13)$.
Part C is 3 points. Part F is 2 points. All others are 5 points.

A. Write the canonical Sum-Of-Products for the function above.
B. Draw the logic circuit for the function f (do not use NAND or NOR gates).
C. Let the cost of a logic circuit be the total number of gates plus the total number of inputs to all gates in the circuit. What is the cost of the circuit in B?
D. Simplify f to <u>3 terms</u> using Boolean algebra.
E. Draw the logic circuit for the simplified version of f in Part D.
F. What is the cost of the new circuit in E?

P7. **(10 points)** Prove theorems 13 and 14 with the methods specified below.
A. Prove theorem 13a and 13b with the truth table method.
B. Prove theorem 14a and 14b using any of the other theorems and axioms.