CprE 281 HW03
ELECTRICAL AND COMPUTER ENGINEERING
IOWA STATE UNIVERSITY

Design Examples, Intro to Verilog
Assigned Date: Third Week
Finish by: Sep. 15, 2025

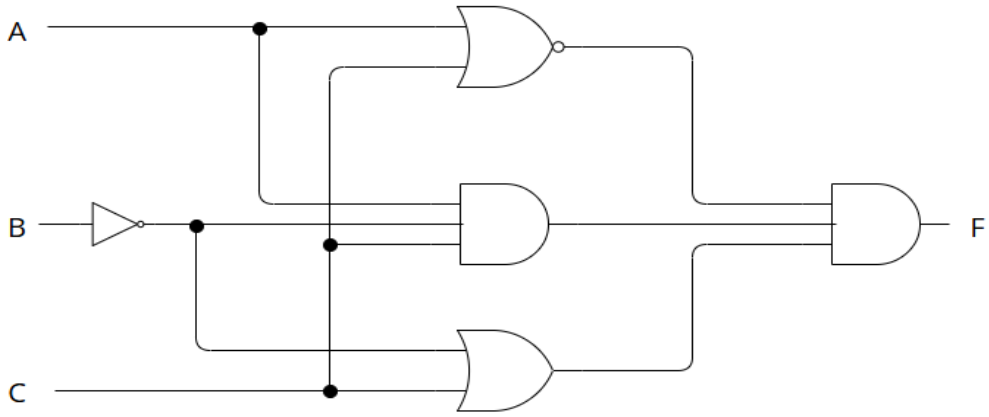
P1. (10 points) Write the following expressions as Verilog behavioral assign statements without simplifying:

E.g., $F = \overline{A}$ as a Verilog assign statement would be "assign F = ~A"

A. $F = \overline{(A + B)} \cdot \left(A + \overline{B}\right)$

B. $F = \overline{(A \cdot B)} + \overline{C} + \overline{(A \cdot B \cdot C)}$

P2. (10 points) Give the structural Verilog code for the circuit shown below. The Verilog module name should be "P2".



P3. (10 points) Given the Behavioral-continuous Verilog code below:

```
module P3(f, a, b, c);
      output f;
      input a, b, c;

      assign f = (~(a&b)|c)&(~(~a|b));

end module
```

A. Rewrite using structural Verilog

B. Convert the Verilog code into a Boolean algebra expression in the form $f(a, b, c) = \cdots$

P4. (20 points) Consider the Boolean algebra expression

$f(A, B, C) = \overline{\left(A + \overline{B} \cdot C\right)} + \left(AB\overline{C}\right) + \overline{(C + B)}$.

A. Draw a truth table for this expression.

B. Represent the function as both a minterm and maxterm expression.

C. From the maxterm expression derive the canonical POS expression.

D. Draw an unsimplified circuit diagram for the canonical POS expression.

P5. (15 points) Show how to implement the following:

A. XOR with only 5 NOR gates.
B. 2-to-1 MUX with only 4 NAND gates.
C. 8-to-1 MUX using only 2-to-1 MUX's.

P6. (15 points): Consider the 3-input logic circuit with truth table:

A	B	C	f
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1

A. Find the minterm summation expression for the truth table.
B. Write the canonical SOP equation corresponding to the minterm expression.
C. Using Boolean algebra, simplify the canonical SOP equation.

P7. (20 points):

A. Given the expression $F(A,B,C) = \sum m(2,3,5,7)$. Use Boolean algebra to derive a simplified SOP expression.
B. Given the expression $F(A,B,C) = \prod M(0,1,4,6)$. Use Boolean algebra to derive a simplified POS expression.
C. Prove that the answer in B is equivalent to the answer in A. Hint: start with the POS expression and use Boolean Algebra to derive the SOP expression.
D. You have to implement a Boolean expression using only NOR gates. Would using NOR gates be more efficient for a Product of-Sums (POS) expression or a Sum-of Products (SOP) expression? Why?