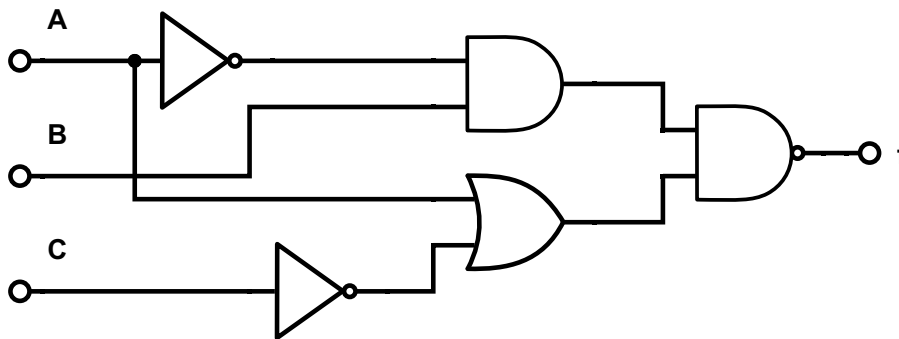


P1. (10 points) Write the following expressions as Verilog behavioral assign statements without simplifying:

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

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

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



P3. (10 points) Consider the following Verilog code.

```

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

  not(n_s, s      );
  and(s_a, a,    n_s);
  and(s_b, b,    s  );
  or (f,   s_a, s_b);

end module

```

- A. Fix all syntax errors in the Verilog code.
 B. Convert the Verilog code into a Boolean algebra expression in the form $f(a, b, s) = \dots$

P4. (20 points) Consider the Boolean algebra expression

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

- A. Draw a truth table for this expression.
 B. Represent the function as both a minterm and maxterm expression.
 C. From the minterm expression derive a SOP expression.
 D. From the maxterm expression derive a POS expression.

P5. (10 points) Consider the following function:

$$f(A, B, C) = \prod M(0, 4, 5)$$

- A. Find the simplest POS expression.
- B. Draw an unsimplified circuit diagram for the POS expression.

P6. (20 points) Consider a three-input logic circuit represented by the truth table below.

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

- A. **(5 points)** Derive the simplified SOP expression.
- B. **(5 points)** Derive the simplified POS expression.
- C. **(10 points)** Implement one of your expressions using **either** NAND or NOR gates while also keeping the gate cost no greater than 7. Your answer must only contain one type of gate. You may use the 3 and 4 input variants of NAND and NOR gates.

P7. (20 points): Consider the 3 input logic circuit with truth table:

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

- A. **(5 points)** Find the minterm summation expression for the truth table.
- B. **(5 points)** Write the unsimplified SOP equation corresponding to the minterm expression.
- C. **(10 points)** Using boolean algebra, simplify your SOP equation.