Cpr E 281 HW04
ELECTRICAL AND COMPUTER
ENGINEERING
IOWA STATE UNIVERSITY

Minimization and Karnaugh Maps
Assigned: Week 4
Due Date: Sep. 18, 2023

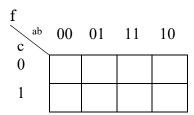**P1 (10 points):** Given the following Verilog code:

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

      always@(*)
            if (c==0)
                  f=(~a)&(~b);
            else
                  f=a&b;

endmodule
```

Fill in the following K-map for f:

f

ab \ c	00	01	11	10
0				
1				

P2 (10 points): Write a Verilog module for a 4-to-1 multiplexer.

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P3 (20 points):

a. Prove Theorem17a of Boolean Algebra ($xy + yz + \bar{x}z = xy + \bar{x}z$) using two K-maps. For instance, show that the K-map for the left-hand side is equivalent to the K-map for the right-hand side.

$xy + yz + \bar{x}z$

z \ xy	00	01	11	10
0				
1				

$xy + \bar{x}z$

z \ xy	00	01	11	10
0				
1				

b. Prove Theorem17b ($(x + y)(y + z)(\bar{x} + z) = (x + y)(\bar{x} + z)$) with truth tables. That is, show that the truth table for the left-hand side is the same as the truth table for the right-hand side.

P4 (15 points): Derive the simplified SOP expressions that correspond to the following K-maps:

F_1

C \ AB	00	01	11	10
0	0	1	1	0
1	1	1	1	1

F_2

YZ \ WX	00	01	11	10
00	0	1	0	0
01	0	1	1	0
11	0	1	1	0
10	0	1	1	0

F_3

YZ \ WX	00	01	11	10
00	1	0	0	1
01	0	0	0	0
11	0	1	1	0
10	1	1	1	1

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P5 (15 points): Derive the simplified POS expressions that correspond to the following K-maps:

F_1

C \ AB	00	01	11	10
0	0	1	0	0
1	1	0	0	1

F_2

YZ \ WX	00	01	11	10
00	1	0	0	1
01	0	0	0	0
11	0	0	0	0
10	1	0	0	1

F_3

YZ \ WX	00	01	11	10
00	1	0	0	1
01	1	0	0	1
11	1	1	1	1
10	1	0	0	1

P6 (10 points): Use Karnaugh Maps to convert the following expressions to <u>simplified SOP expressions</u>:

    a. $Q_1(A, B, C, D) = AB\bar{C} + ABD + AC\bar{D} + A\bar{B}\bar{C}D$

    b. $Q_2(A, B, C, D) = \sum m(1,5,6,7)$

P7 (10 points): Use Karnaugh Maps to convert the following expressions to <u>simplified POS expressions</u>:

    a. $Q_1(A, B, C, D) = (A + \bar{B} + C)(\bar{A} + \bar{B} + D)(A + B + D)(A + B + \bar{D})$

    b. $Q_2(A, B, C, D) = \prod M(2,4,7,11)$

P8 (10 points): For each expression below, derive the simplest SOP expression using don't care terms for simplification wherever possible:

    a. $H_1(a, b, c) = \sum m(0,3,5,7) + D(1,4)$

    b. $H_2(a, b, c, d) = \prod M(1,5,9,12,15) + D(3,4,7,11)$