Nick McCullough - 950337388 - Lab Section 7

Cpr E 281 HW05 ELECTRICAL AND COMPUTER ENGINEERING IOWA STATE UNIVERSITY	Representation and Arithmetic Assigned: Week 7 Due Date: March. 05, 2023

P1 (12 points): Convert the following numbers to IEEE 754 Single-Precision Floating Point binary format:

A. -8.125
B. 239
C. 19/512

P2 (12 points): Convert the following numbers from IEEE 754 Single-Precision Floating Point format to decimal. Note that each number is given in hexadecimal. You may leave the result as a fraction.

A. $BF000000_{16}$
B. $42C80000_{16}$
C. $BD600000_{16}$

P3 (20 points). Consider a function F with 4 bits of input A_3, A_2, A_1, A_0 such that the output of F is 1 if the unsigned binary number represented by $A_3A_2A_1A_0$ is prime (i.e. 2, 3, 5, 7, 11, or 13). Otherwise, the output of F is 0.

a. Write the truth table for F.
b. Implement F using only a 16-to-1 MUX.
c. Implement F using an 8-to-1 MUX, and some AND, OR, and NOT gates.
d. Implement F using an 4-to-1 MUX, and some AND, OR, and NOT gates.
e. Using Shannon's expansion, implement F using a 2-to-1 MUX, and some AND, OR, and NOT gates.

P4 (20 points): Given $P(A,B,C,D) = BCD + A\bar{B}C + \overline{(A+C+D)(B+D)}$

A. Implement this function using one 16-to-1 MUX.
B. Implement this function using one 8-to-1 MUX and NOT gates.
C. Implement this function using one 4-to-1 MUX with A and B as the select lines and a minimal number of AND/OR/NOT gates.
D. Implement this function using one 2-to-1 MUX with C as the select line and some AND/OR/NOT gates. Do not implement P separately with gates and place the MUX in a trivial connection with the rest of the circuit.
E. Implement this function using one 4-to-1 MUX with B and C as the select lines.

P5 (14 points): Implement the function $G(w,x,y,z) = \sum m(5,7,8,10,13,14,15)$ as follows:

a) Use a K-map to show that G can be written as $G = xz + w\bar{x}\bar{z} + wy\bar{z}$
b) Implement G using only a minimal number (3) of 2-1 MUXes and no other gates (NOT gates are not allowed, either). Hint: Use Shannon's Expansion Theorem a few times.

P6 (22 points). Implement the following functions using Shannon's expansion:

a. Implement $F = w_1w_2 + w_1w_3 + w_2w_3$ using only 2-to-1 MUXs
b. Implement $F = w_1w_2 + w_1w_3 + w_2w_3$ using only 4-to-1 MUXs

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P1) A) -8.125 B) 239 C) 19/512

A) -8.125 in binary IEEE 754 Floating Point is:

1 | 10000010 | 00000100000000000000000

Sign | exponent | Mantissa

B) 239 in binary IEEE 754 Floating Point is:

0 | 10000110 | 1101111 0000 0000 0000 0000

Sign | exponent | Mantissa

C) 19/512 in binary IEEE 754 Floating Point is:

0 | 10000110 | 1101111 0000 0000 0000 0000

Sign | exponent | Mantissa

P2) A) $BF000000_{16}$ B) $42C80000_{16}$ C) $BD600000_{16}$

A) $BF000000_{16}$

1 | 01111110 | 000 0000 0000 0000 0000 0000

sign | exponent | mantissa

$-$ 126 0

$(-1^1) \cdot (2^{126-127}) \cdot (1) = -2^{-1}$ or $\boxed{-\frac{1}{2} \text{ or } -0.5_{10}}$

sign exponent mantissa

B) $42C80000_{16}$

$133-127=6=2^6$

0 | 10000101 | 1001 000 0000 0000 0000 0000

sign | exp. | mantissa

$+$ 133 $\frac{1}{2}+\frac{1}{2^4}=0.5625$

$(-1)^0 \cdot 2^6 \cdot 1.5625 = 64(1.5625) = \boxed{100_{10}}$

sign exp mantissa

C) $BD600000_{16}$

$122-127=-5=2^{-5}$

1 | 01111010 | 110 0000 0000 0000 0000 0000

sign | exp | mantissa

$-$ 122 $\frac{1}{2}+\frac{1}{4}=3/4$ or 0.75

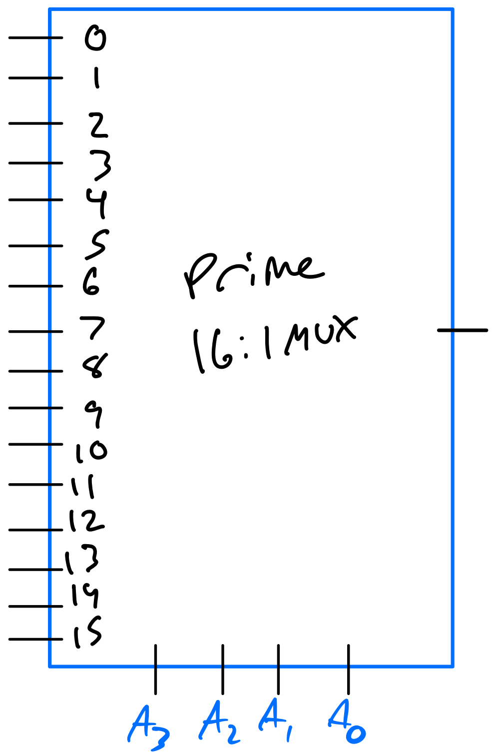
$(-1)^1 \cdot 2^{-5} \cdot 1.75 = \boxed{-\frac{1.75}{32} \text{ or } -0.0546875_{10}}$

P3)

a)

A_3	A_2	A_1	A_0	F
0	0	0	0	0
0	0	0	1	0
0	0	1	0	1
0	0	1	1	1
0	1	0	0	0
0	1	0	1	1
0	1	1	0	0
0	1	1	1	1
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	0
1	1	1	1	0

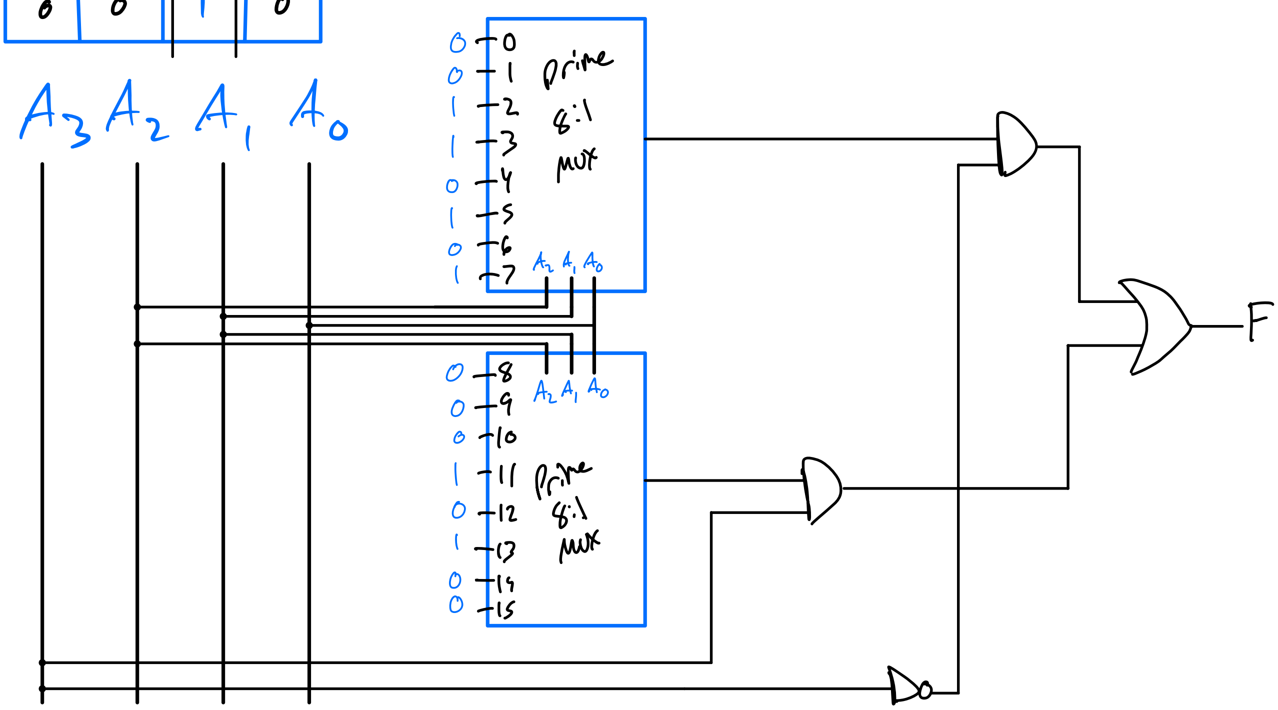
b)



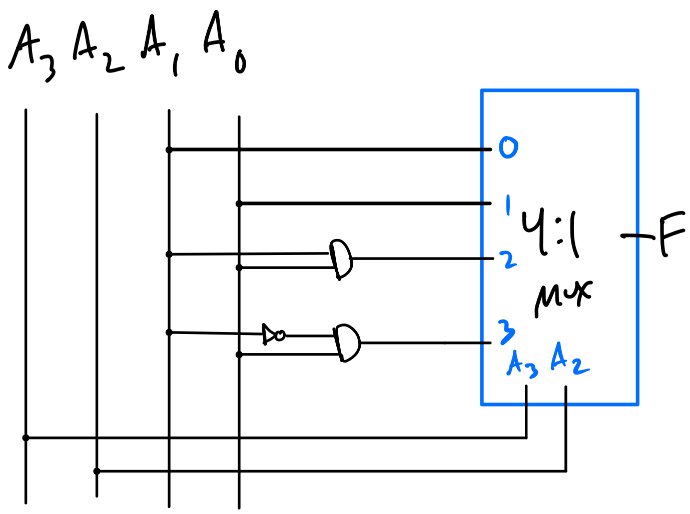
F (A_3A_2 \ A_1A_0)				
	0	0	1	1
	0	1	1	0
	0	1	0	0
	0	0	1	0

$$= \overline{A_3}\,\overline{A_2}\,A_1 + \overline{A_3}\,A_2\,A_0 + \overline{A_2}\,A_1\,A_0 + A_2\,\overline{A_1}\,A_0$$

c)



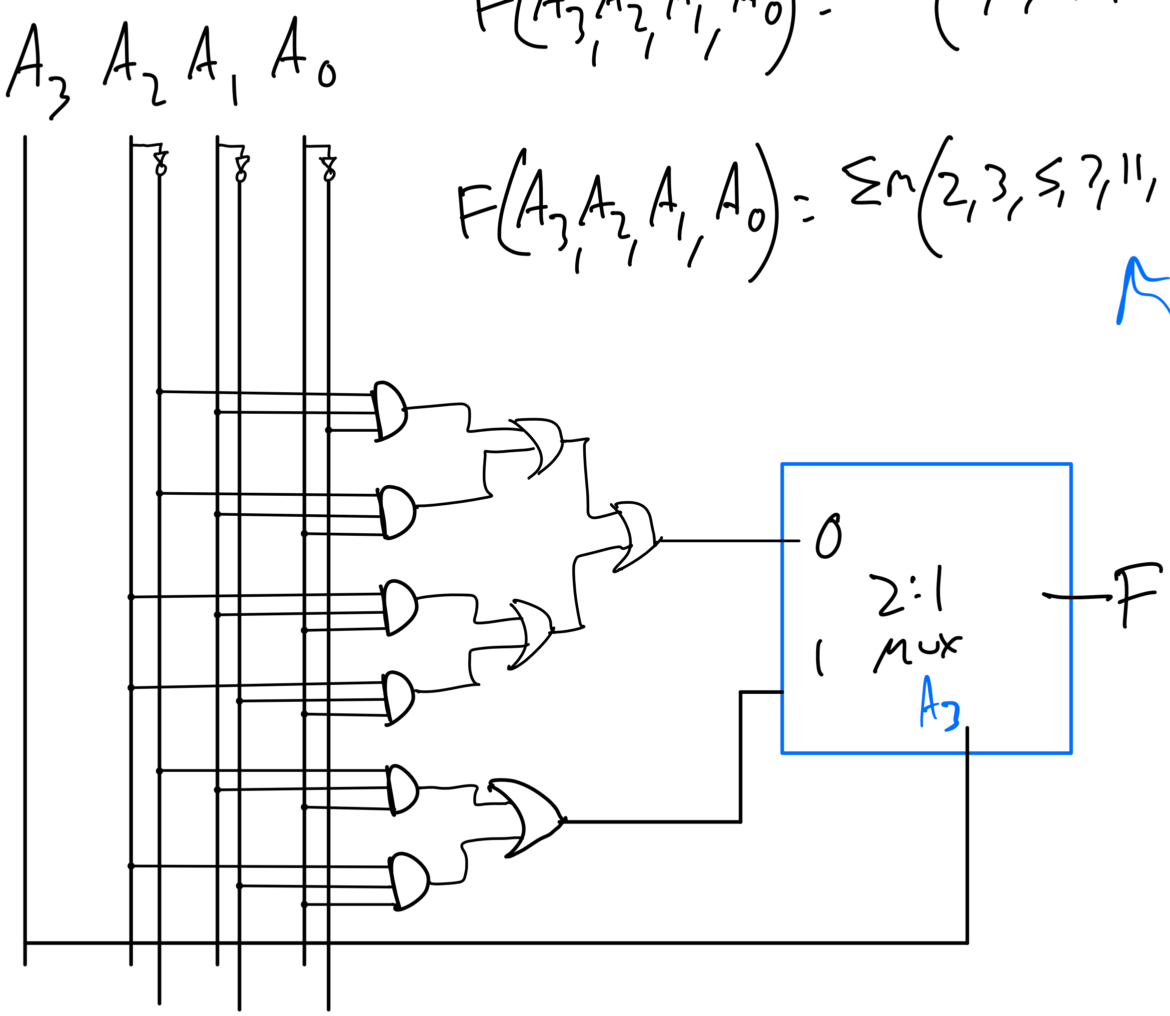
D)



A_1A_0 \ A_3A_2	N_0 00	N_1 01	N_2 10	N_3 11
00	0	4	8	12
01	1	$\boxed{5}$	9	$\boxed{13}$
10	$\boxed{2}$	6	10	14
11	$\boxed{3}$	$\boxed{7}$	$\boxed{11}$	15

$$F(A_3, A_2, A_1, A_0) = \Sigma m(2,3,5,7,11,13)$$

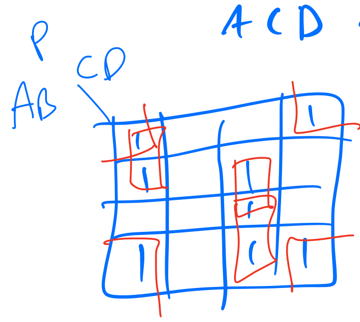
E)



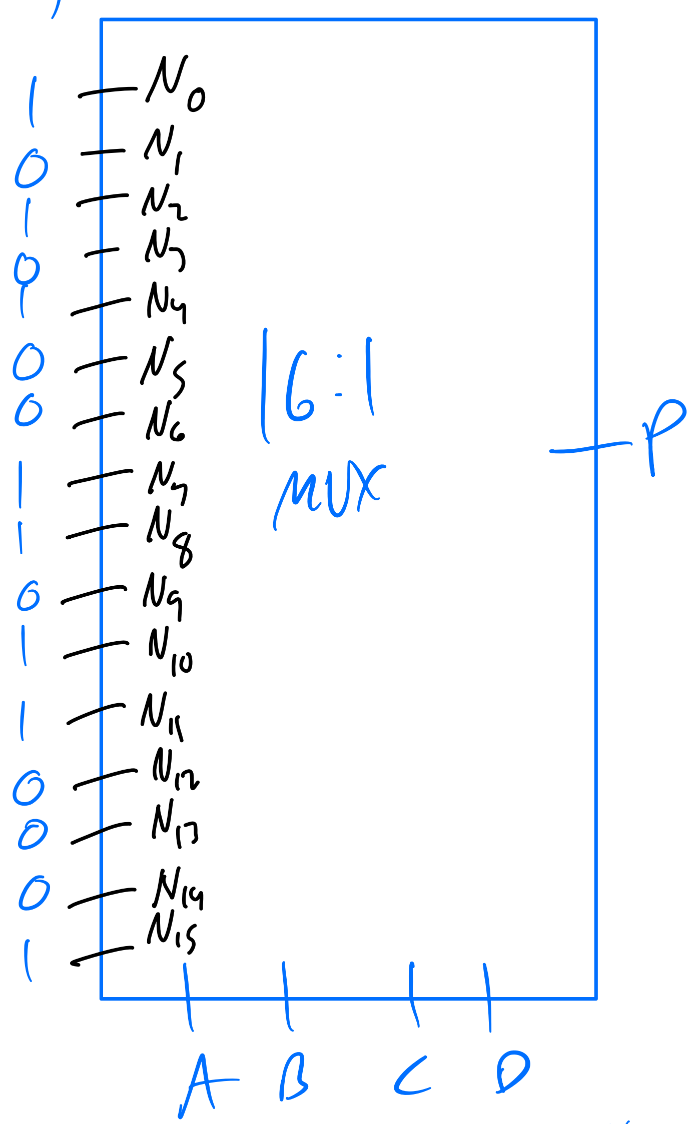
$$F(A_3, A_2, A_1, A_0) = \Sigma m(2,3,5,7,11,13)$$

P4) $P(A,B,C,D) = BCD + A\bar{B}C + \overline{(A+C+D)(B+D)}$

$\bar{A}\bar{C}\bar{D} + \bar{B}\bar{D}$



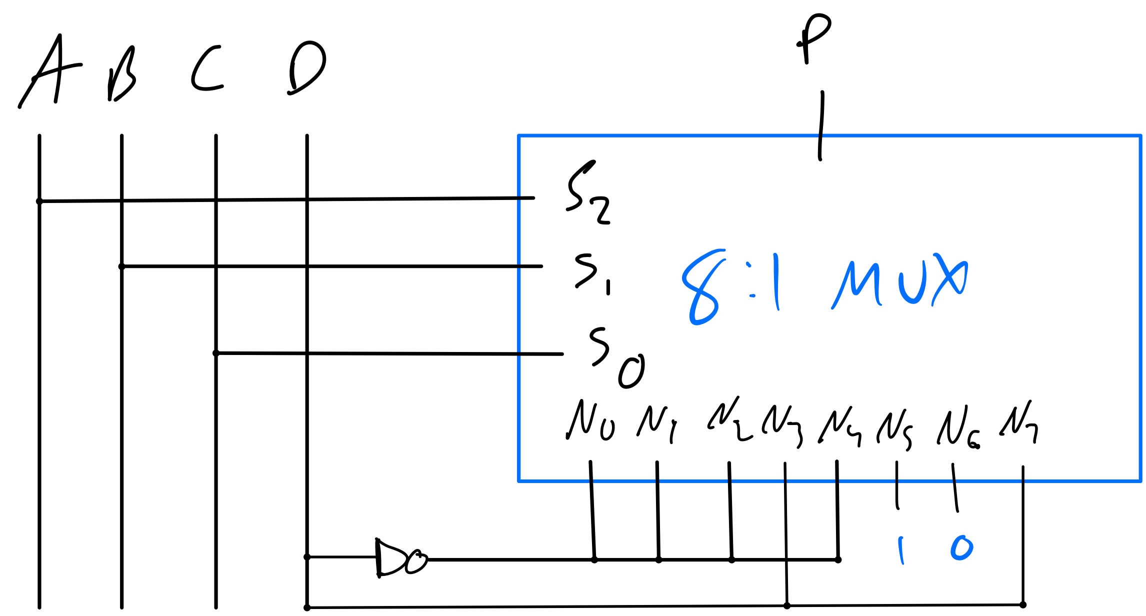
A)



A_3	A_2	A_1	A_0	P
0	0	0	0	1
0	0	0	1	0
0	0	1	0	1
0	0	1	1	0
0	1	0	0	1
0	1	0	1	0
0	1	1	0	0
0	1	1	1	1
1	0	0	0	1
1	0	0	1	0
1	0	1	0	1
1	0	1	1	1
1	1	0	0	0
1	1	0	1	0
1	1	1	0	0
1	1	1	1	1

B)

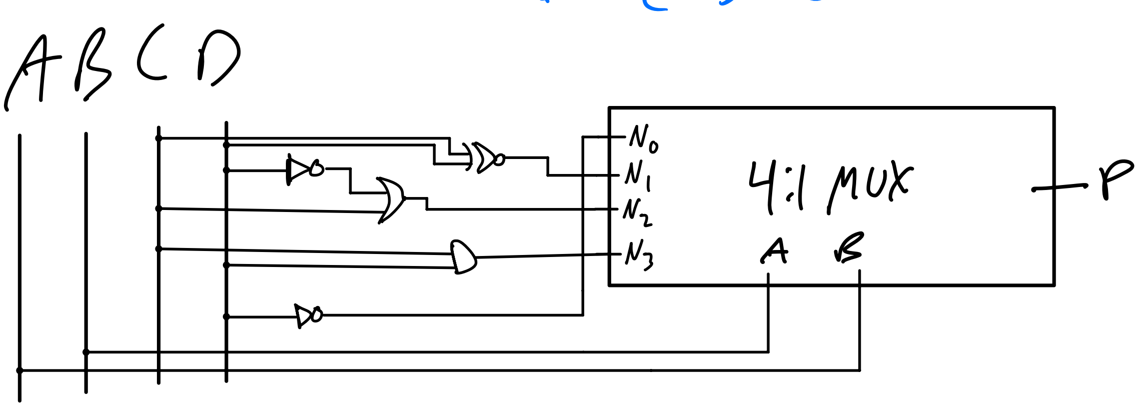
	N_0	N_1	N_2	N_3	N_4	N_5	N_6	N_7
ABC	000	001	010	011	100	101	110	111
$\bar{D}$ 0	$\boxed{0}$	$\boxed{2}$	$\boxed{4}$	6	$\boxed{8}$	$\boxed{10}$	12	14
D 1	1	3	5	$\boxed{7}$	9	$\boxed{11}$	13	$\boxed{15}$



C)

AB		00	01	10	11
$\bar{C}\bar{D}$	00	$\boxed{0}$	$\boxed{4}$	$\boxed{8}$	12
$\bar{C}D$	01	1	5	9	13
$C\bar{D}$	10	$\boxed{2}$	6	$\boxed{10}$	14
CD	11	3	$\boxed{7}$	$\boxed{11}$	$\boxed{15}$

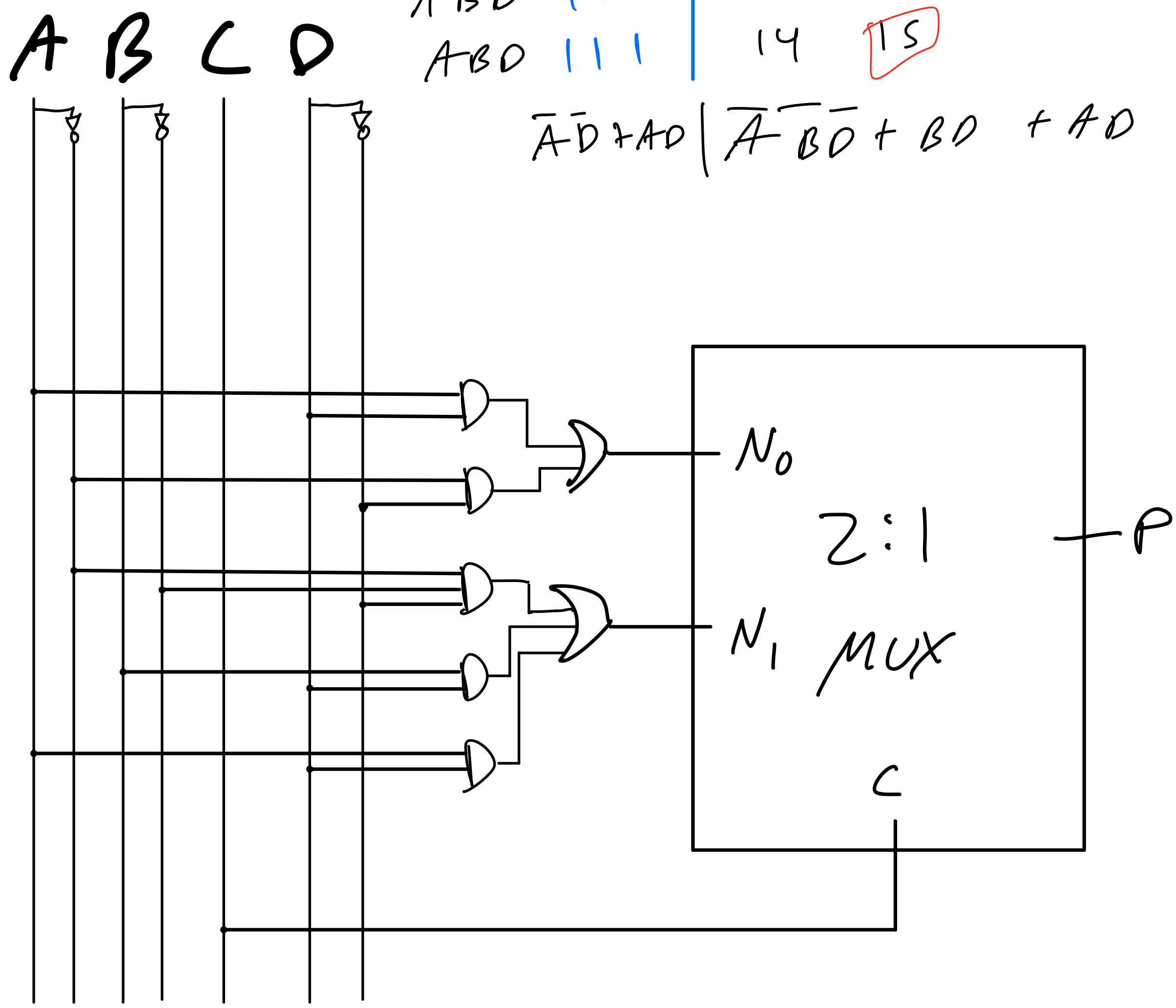
$\bar{D}$ $\quad C \odot D \quad C + \bar{D} \quad CD \quad = \bar{C}\bar{D} + CD$



D) 2:1

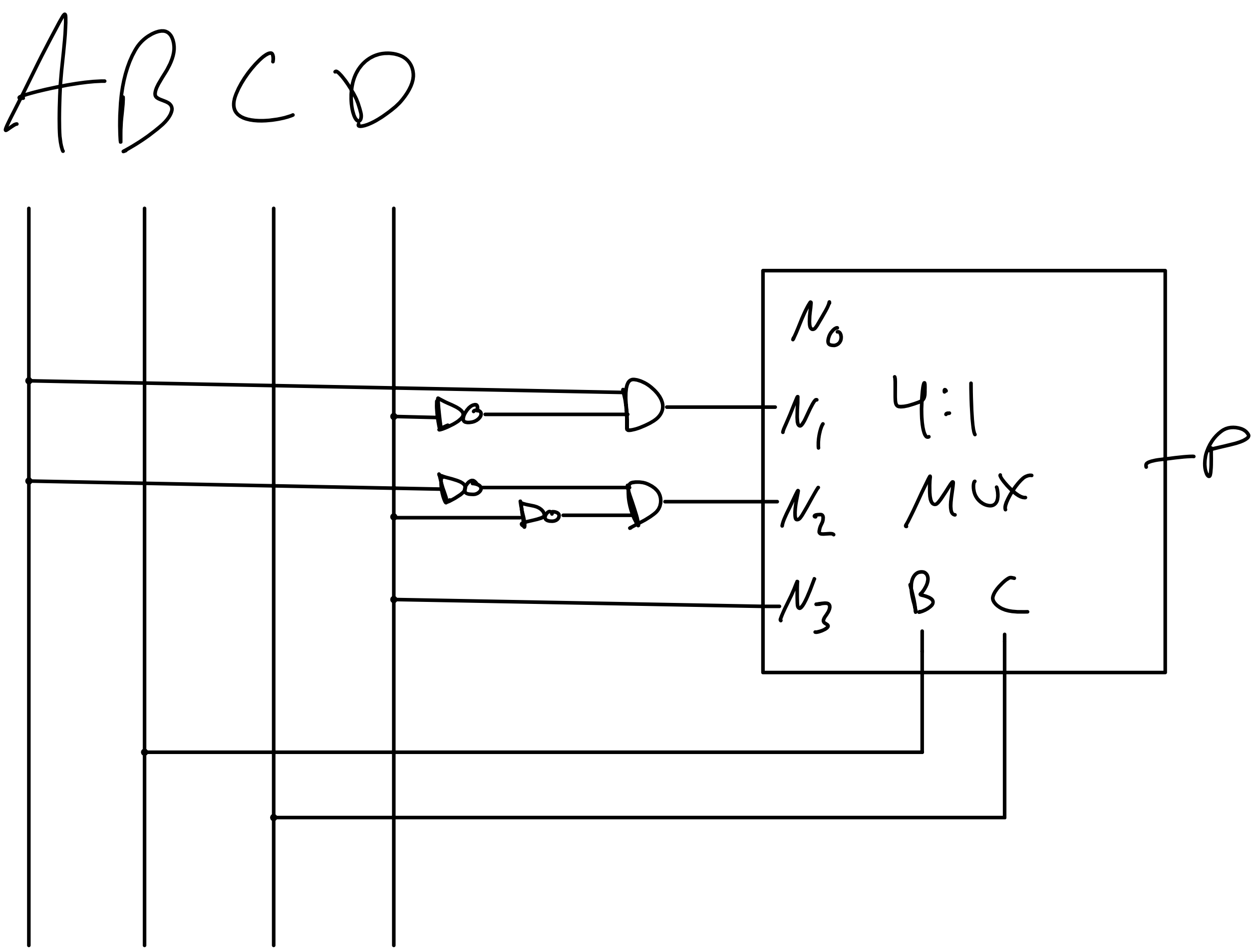
	C	N_0 (C = 0)	N_1 (C = 1)
$\bar{A}\bar{B}\bar{D}$	000	0	2
$\bar{A}\bar{B}D$	001	1	3
$\bar{A}B\bar{D}$	010	4	5
$\bar{A}BD$	011	6	7
$A\bar{B}\bar{D}$	100	8	9
$A\bar{B}D$	101	10	11
$AB\bar{D}$	110	12	13
ABD	111	14	15

$\bar{A}\bar{D} + AD \mid \bar{A}\bar{B}\bar{D} + BD + AD$



E)

BC	N_0 00	N_1 01	N_2 10	N_3 11
$\bar{A}\bar{D}$ 00	0	2	4	6
$\bar{A}D$ 01	1	3	5	7
$A\bar{D}$ 10	8	10	12	14
AD 11	9	11	13	15
	$\bar{D}$	$A+\bar{D}$	$\bar{A}\bar{D}$	D



P5)

$G(w, x, y, z) = \sum m(5, 7, 8, 10, 13, 14, 15)$

A)

G: wx \ yz	00	01	11	10
00	0	0	0	0
01	0	1	1	0
11	0	1	1	1
10	1	0	0	1

xz

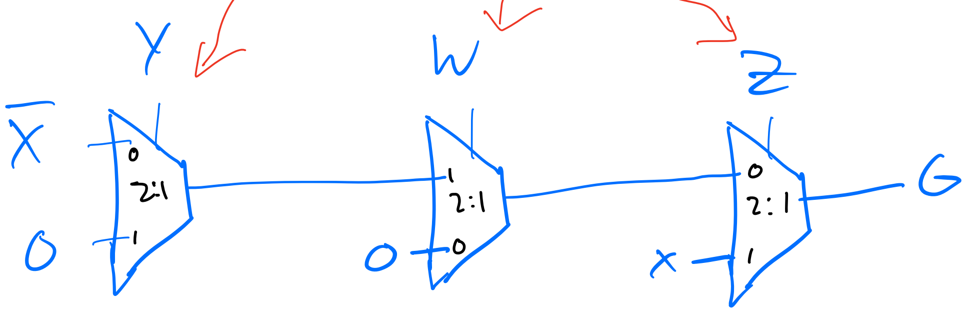
$wy\bar{z}$

$w\bar{x}\bar{z}$

$G = xz + wy\bar{z} + w\bar{x}\bar{z}$

B) factor $\bar{z}$ out $\bar{z}(wy + w\bar{x}) + xz$

$G = \bar{z}(w(y+\bar{x})) + xz$



P6)

A) $F = w_1w_2 + w_1w_3 + w_2w_3$ using 2:1 MUX

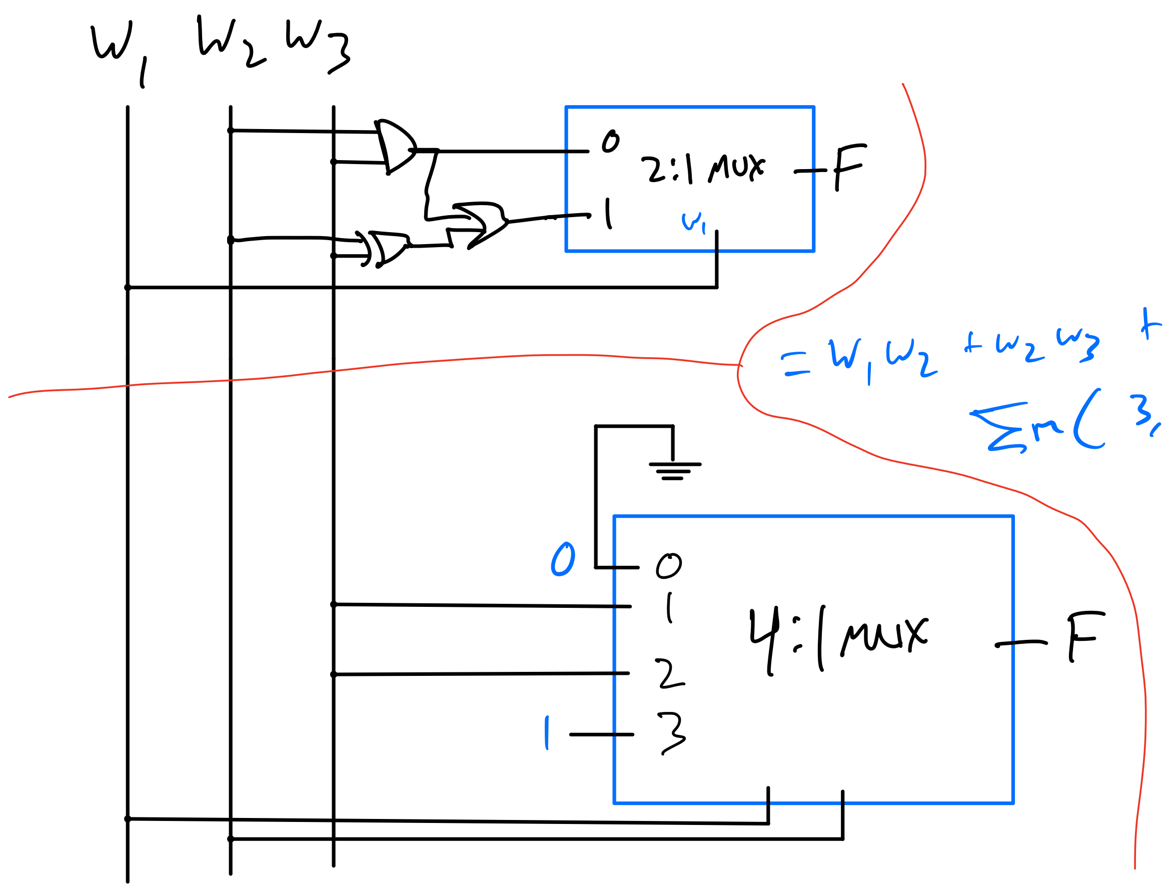
$$w_1w_2(w_3+\overline{w_3}) + w_1w_3(w_2+\overline{w_2}) + w_2w_3(w_1+\overline{w_1})$$

$$w + \overline{w} = 1$$

$$F = \sum m(3,5,6,7)$$

$$= w_3w_2w_1 + w_3w_2\overline{w_1} + w_3\overline{w_2}w_1 + \overline{w_3}w_2w_1$$

$$= \overline{w_1}(w_2w_3) + w_1(w_2w_3 + \overline{w_2}w_3 + w_2\overline{w_3})$$



$= w_1w_2 + w_2w_3 + w_2w_3$

$\sum m(3,5,6,7)$