Half Adder:

Expression:

Sum

A \ B	0	1
0	0	1
1	1	0

Carry

A \ B	0	1
0	0	0
1	0	1

$G1 = \bar{A}B \quad G2 = A\bar{B}$

$X = \bar{A}B + A\bar{B}$

$= A \oplus B$

$G1 = A \cdot B$

$X = AB$

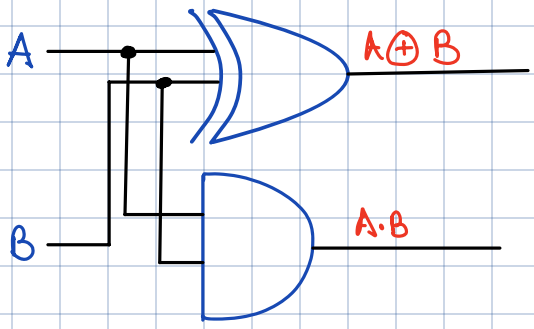
Truth table

A	B	Sum $A \oplus B$	Carry $A \cdot B$
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

Sum: $A \oplus B$

Carry: $A \cdot B$

Circuit:



Full adder

Expression:

Sum

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

$G1 = \bar{A}\bar{B}C_{in}$

$G2 = \bar{A}B\bar{C}_{in}$

$G3 = ABC_{in}$

$G4 = A\bar{B}\bar{C}_{in}$

$X = \bar{A}\bar{B}C_{in} + \bar{A}B\bar{C}_{in} + ABC_{in} + A\bar{B}\bar{C}_{in}$

$= \bar{C}_{in}(\bar{A}B + A\bar{B}) + C_{in}(AB + \bar{A}\bar{B})$

Sum: $A \oplus B \oplus C_{in}$

Carry: $A \cdot B + (A \oplus B) \cdot C_{in}$

Truth table

A	B	Cin	$A \oplus B \oplus C_{in}$	$A \cdot B + (A \oplus B)C_{in}$
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

Let $X = \bar{A}B + A\bar{B}$

$= \bar{C_{in}} X + C_{in} \bar{X}$

$= C_{in} \oplus X$

$= C_{in} \oplus (\bar{A} \oplus \bar{B})$

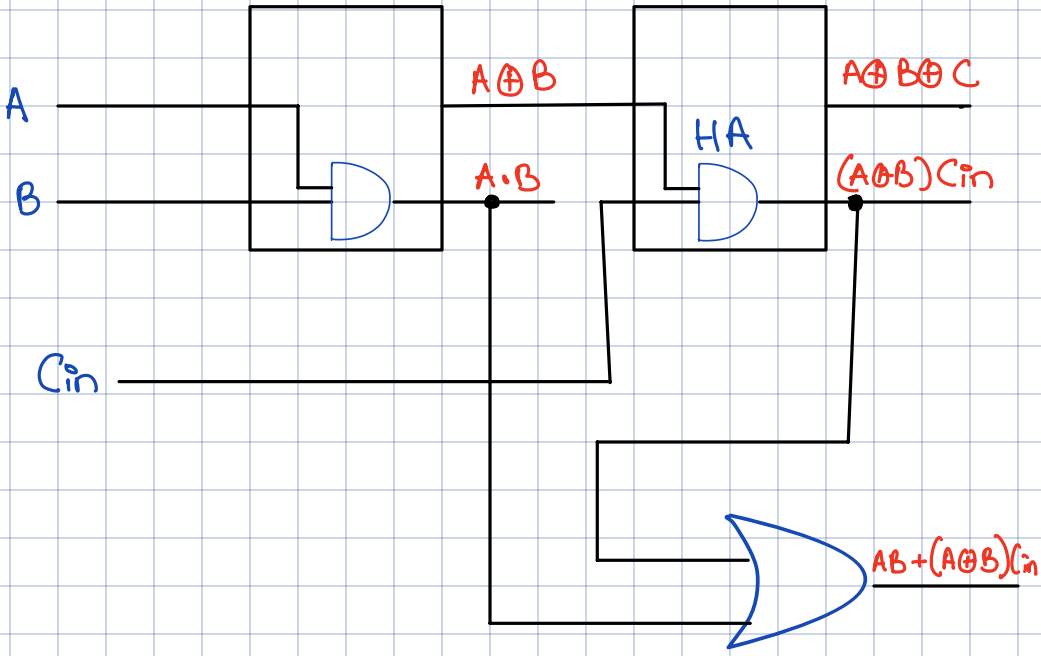
Carry

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

G1 = BC_{in}

G2 = AB

G3 = $C_{in}A$



$X = AB + AC_{in} + BC_{in}$

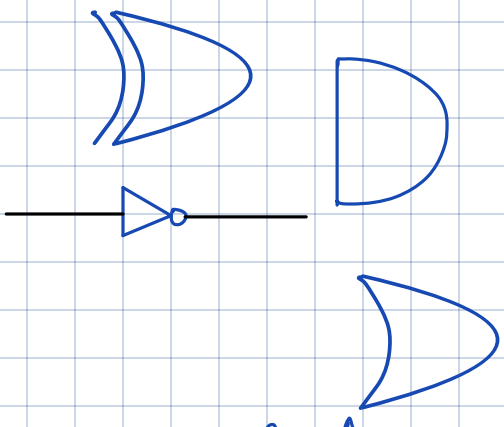
$= AB + AC_{in}(B + \bar{B}) + BC_{in}(A + \bar{A})$

$= AB + ABC_{in} + A\bar{B}C_{in} + ABC_{in} + \bar{A}BC_{in}$

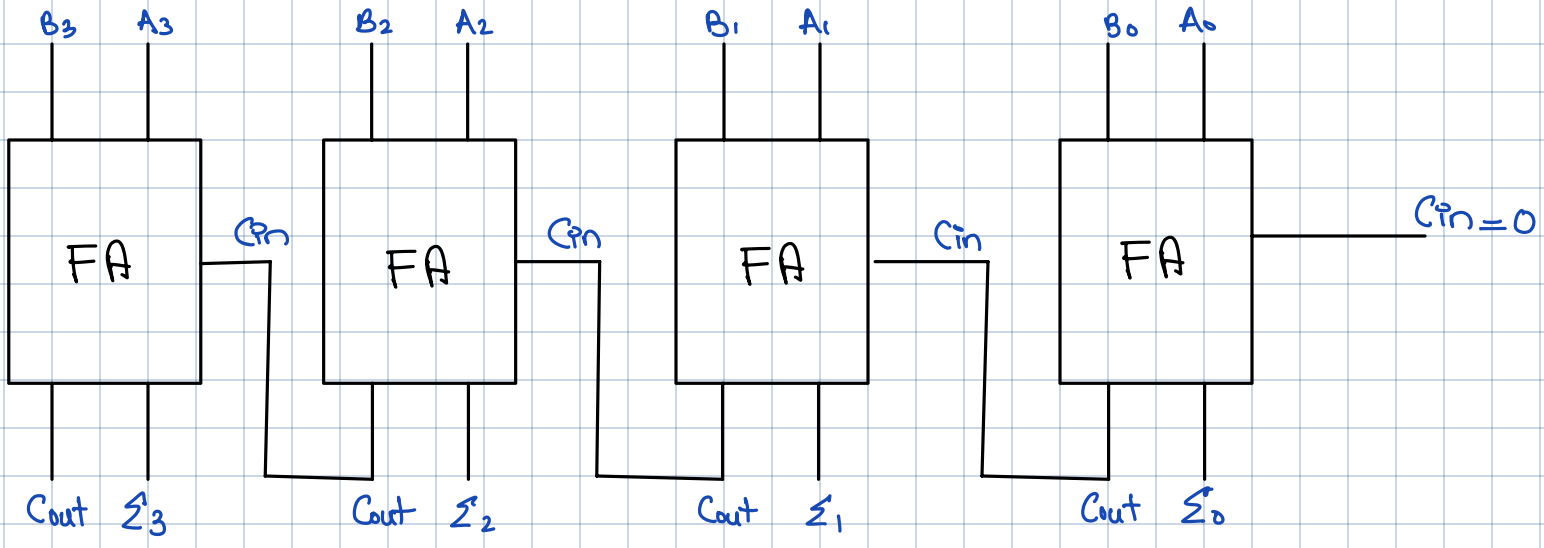
$= AB + ABC_{in} + A\bar{B}C_{in} + \bar{A}BC_{in}$

$= AB(1 + C_{in}) + C_{in}(A\bar{B} + \bar{A}B)$

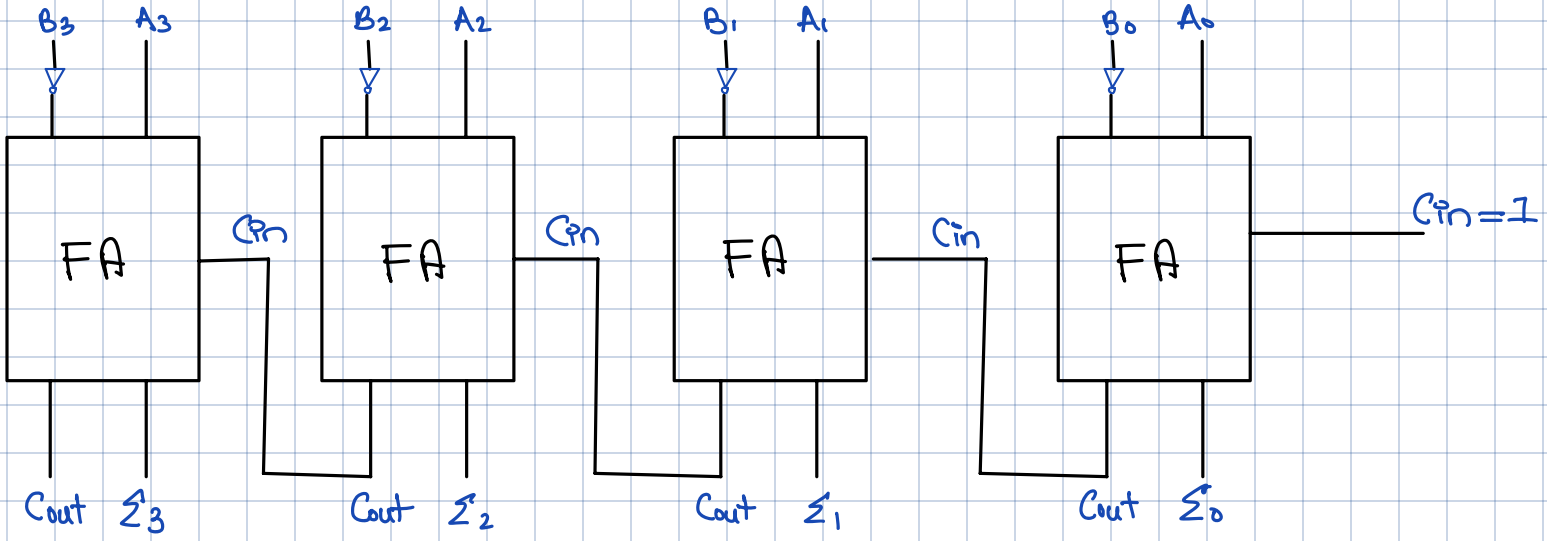
$= AB + (A \oplus B)C_{in}$



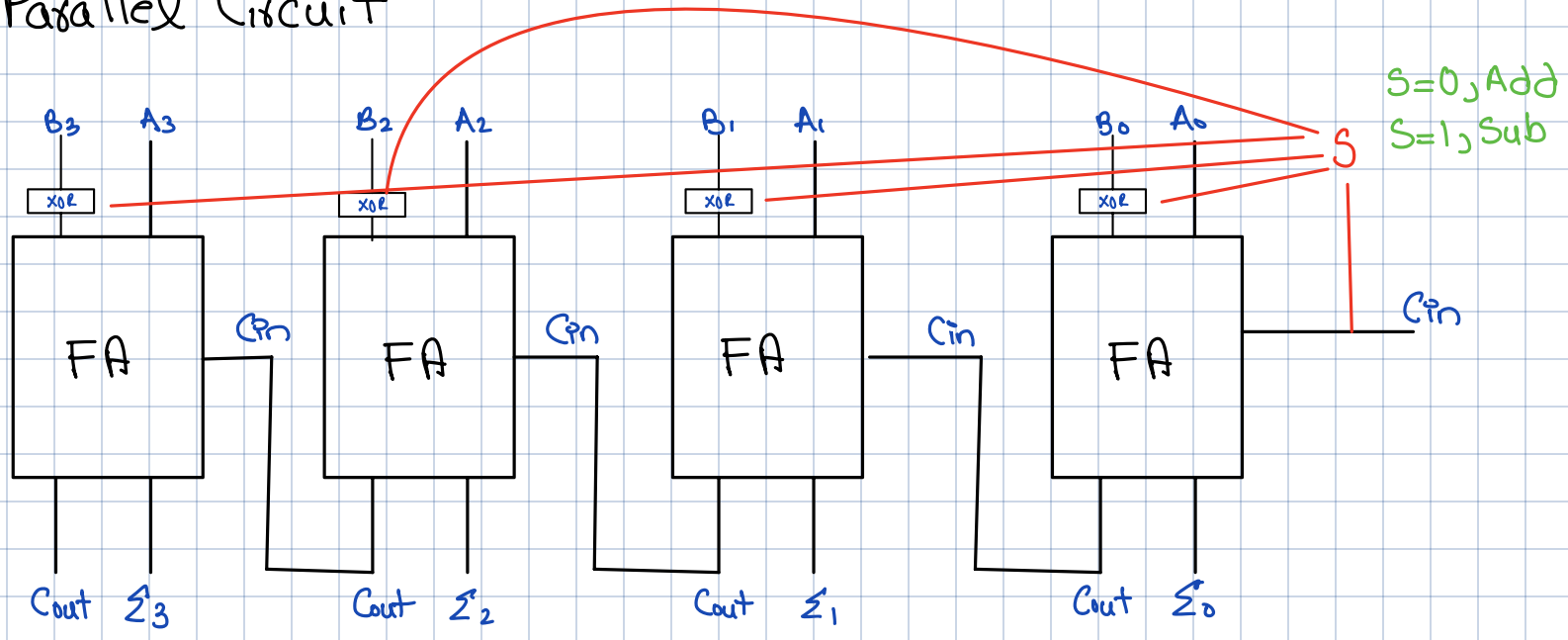
4 bit Adder



4-bit subtractor



Parallel Circuit



Decodes — 2x4

Expression:

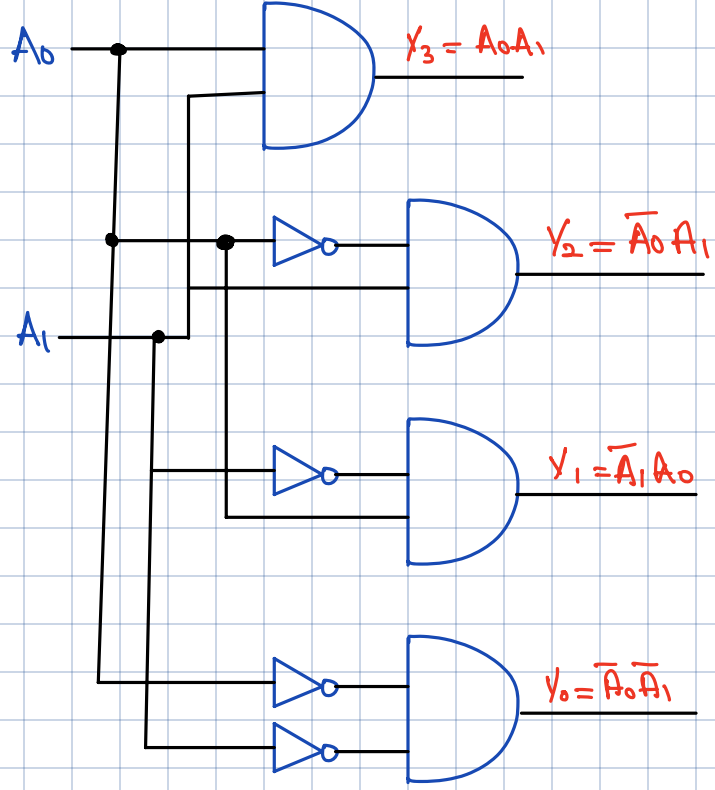
$Y_0 = \bar{A_1}\bar{A_0}$ $Y_2 = A_1\bar{A_0}$

$Y_1 = \bar{A_1}A_0$ $Y_3 = A_1A_0$

Circuit:

Truth table

A1	A0	Y3	Y2	Y1	Y0
0	0	0	0	0	1
0	1	0	0	1	0
1	0	0	1	0	0
1	1	1	0	0	0



Encoder: -4×2

Expression:

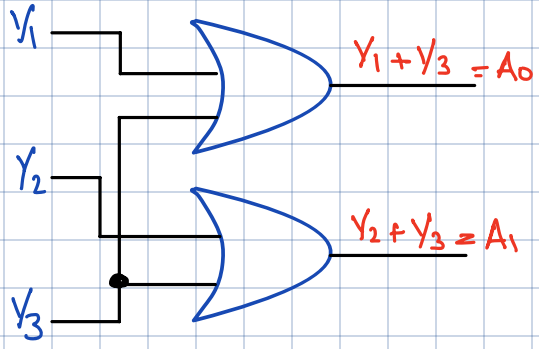
$A_0 = Y_1 + Y_3$

$A_1 = Y_2 + Y_3$

Truth table

Y_3	Y_2	Y_1	Y_0	A_1	A_0
0	0	0	1	0	0
0	0	1	0	0	1
0	1	0	0	1	0
1	0	0	0	1	1

Circuit



Multiplexer

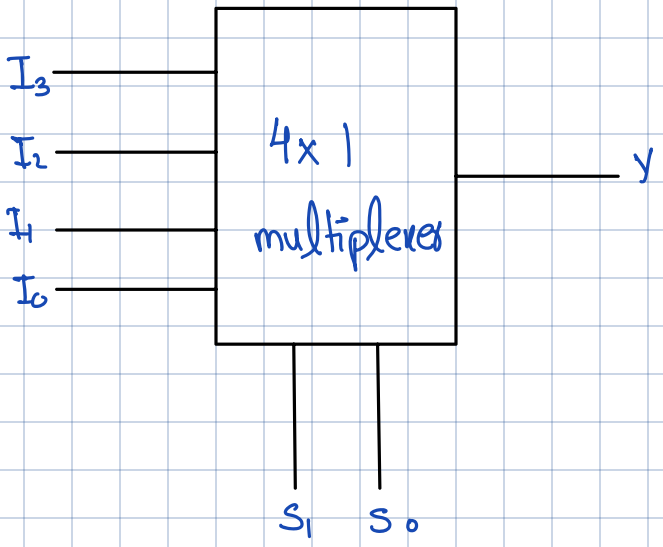
Expression:

$Y = \bar{S}_1\bar{S}_0I_0 + \bar{S}_1S_0I_1 + S_1\bar{S}_0I_2 + S_1S_0I_3$

Truth table

I_3	I_2	I_1	I_0	S_1	S_0	Y
			1	0	0	I_0
		1		0	1	I_1
	1			1	0	I_2
1				1	1	I_3

Circuit:



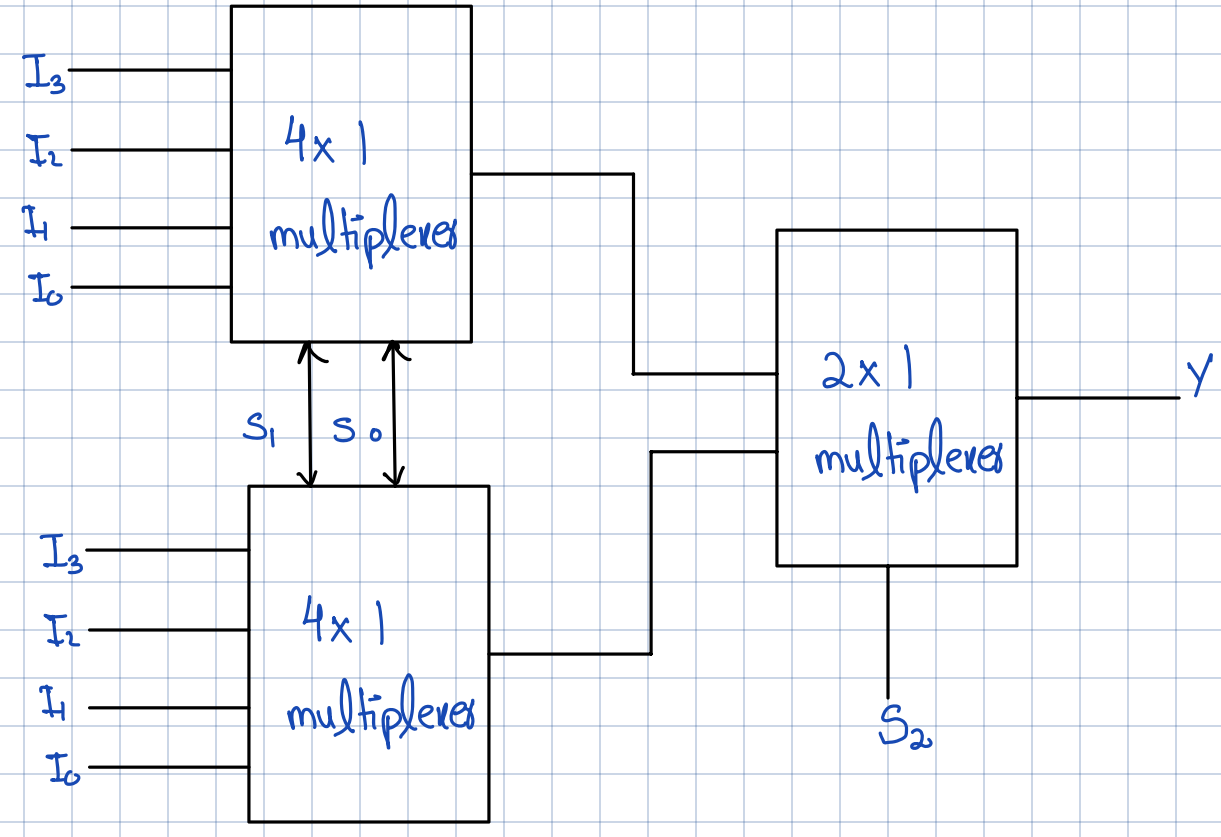
Expression:

$$Y = \bar{S}_2\bar{S}_1\bar{S}_0 I_0 + \bar{S}_2\bar{S}_1 S_0 I_1 + \bar{S}_2 S_1\bar{S}_0 I_2 + \bar{S}_2 S_1 S_0 I_3 + S_2\bar{S}_1\bar{S}_0 I_4 + S_2\bar{S}_1 S_0 I_5 + S_2 S_1\bar{S}_0 I_6 + S_2 S_1 S_0 I_7$$

Truth table

I_7	I_6	I_5	I_4	I_3	I_2	I_1	I_0	S_2	S_1	S_0	Y
							1	0	0	0	I_0
						1		0	0	1	I_1
					1			0	1	0	I_2
				1				0	1	1	I_3
			1					1	0	0	I_4
		1						1	0	1	I_5
	1							1	1	0	I_6
1								1	1	1	I_7

Circuit.



De-Multiplexer

Expression

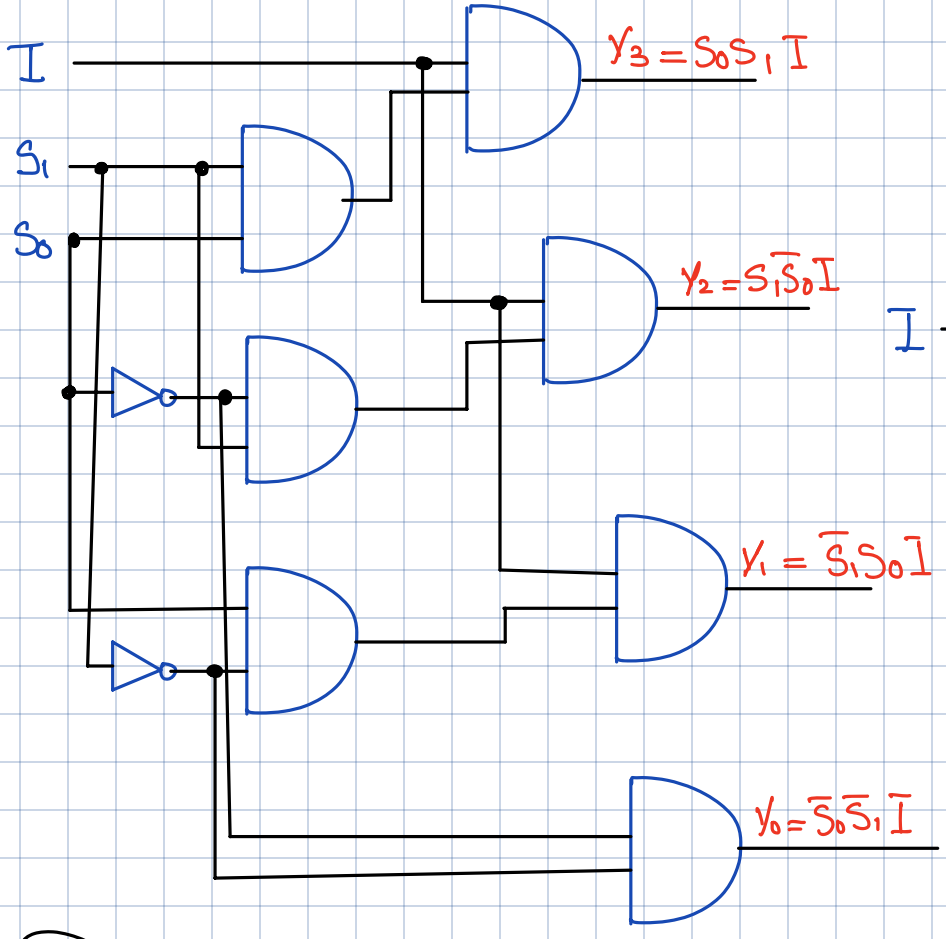
$Y_3 = S_1 S_0 I$ $\quad Y_1 = \bar{S}_1 S_0 I$

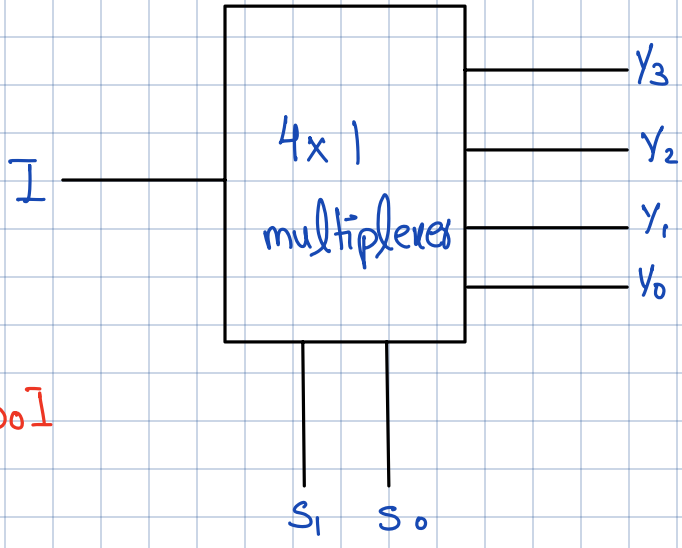
$Y_2 = S_1 \bar{S}_0 I$ $\quad Y_0 = \bar{S}_1 \bar{S}_0 I$

Truth table

I	S_1	S_0	Y_3	Y_2	Y_1	Y_0
I	0	0				I
I	0	1			I	
I	1	0		I		
I	1	1	I			

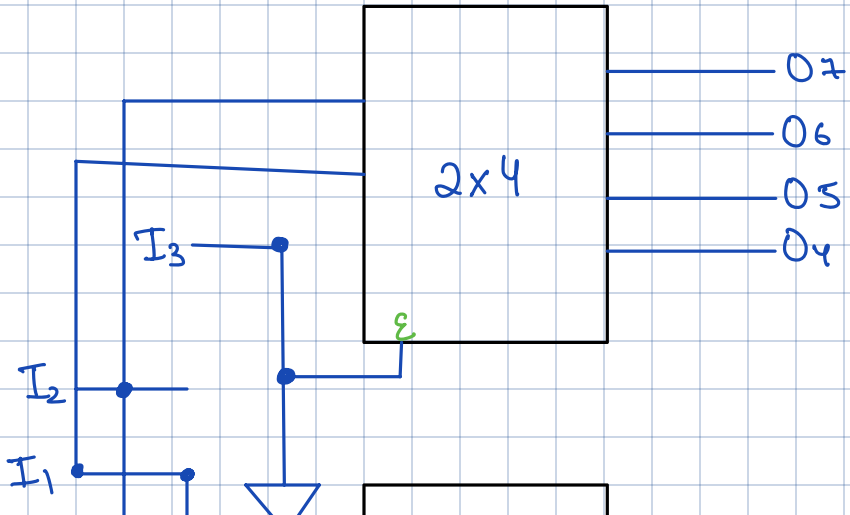
Circuit:



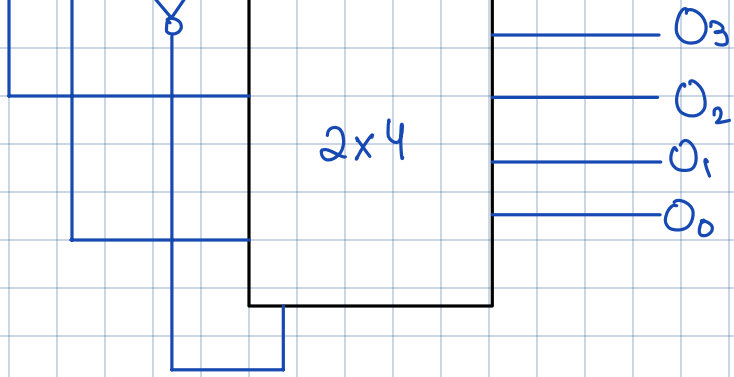


Decoder:

3x8 using 2x4

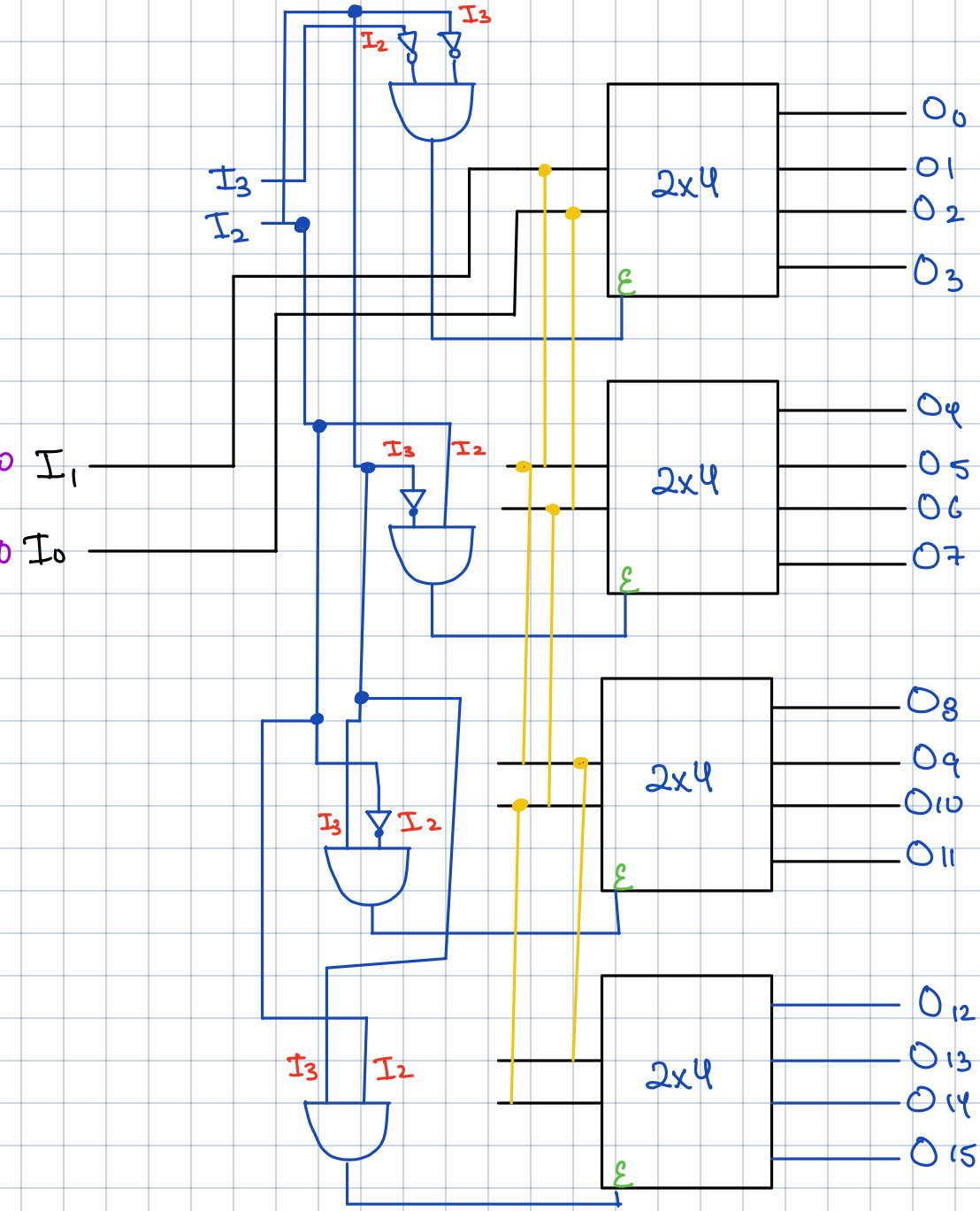


I_3	I_2	I_1	
0	0	0	
0	0	1	O_1
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

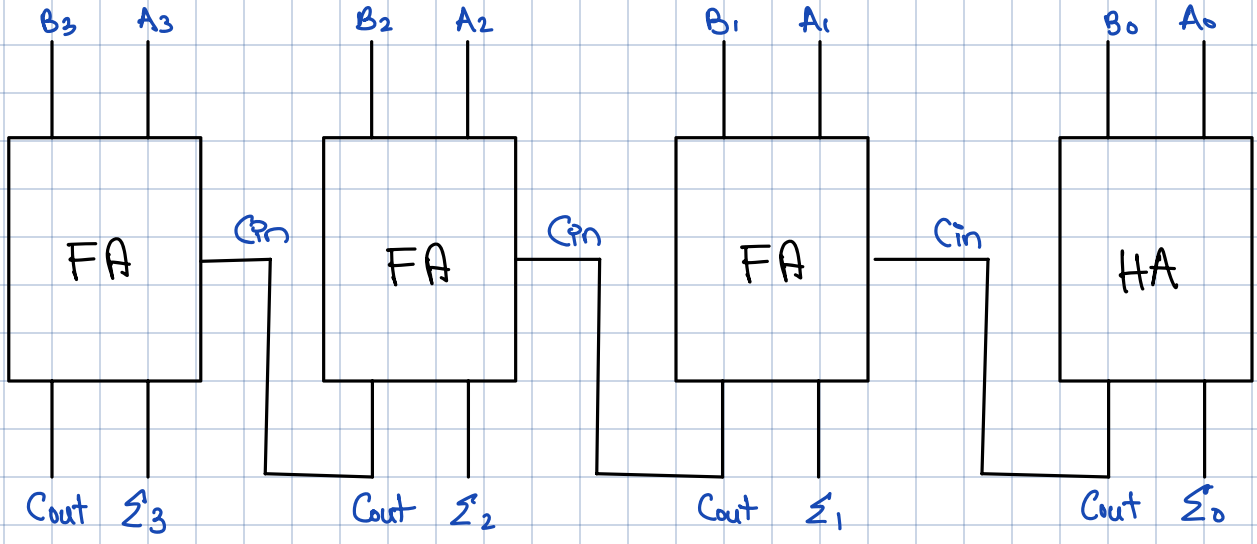


4 x 16 using 2x4

	I_3	I_2	I_1	I_0
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
	0	1	0	1
	0	1	1	0
	0	1	1	1
	1	0	0	0
	1	0	0	1
	1	0	1	0
	1	0	1	1
	1	1	0	0
	1	1	0	1
	1	1	1	0
	1	1	1	1

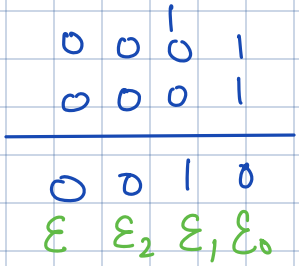


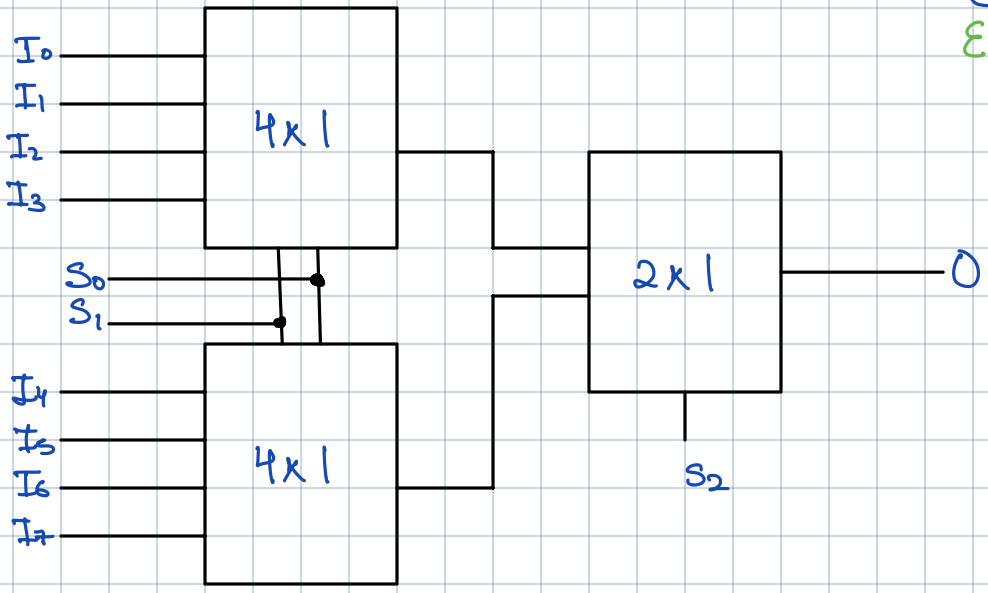
4 bit adder using half adder:



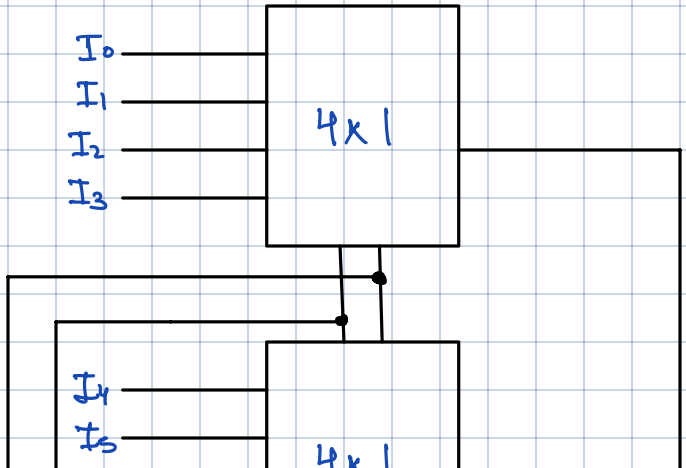
Multiplexers:

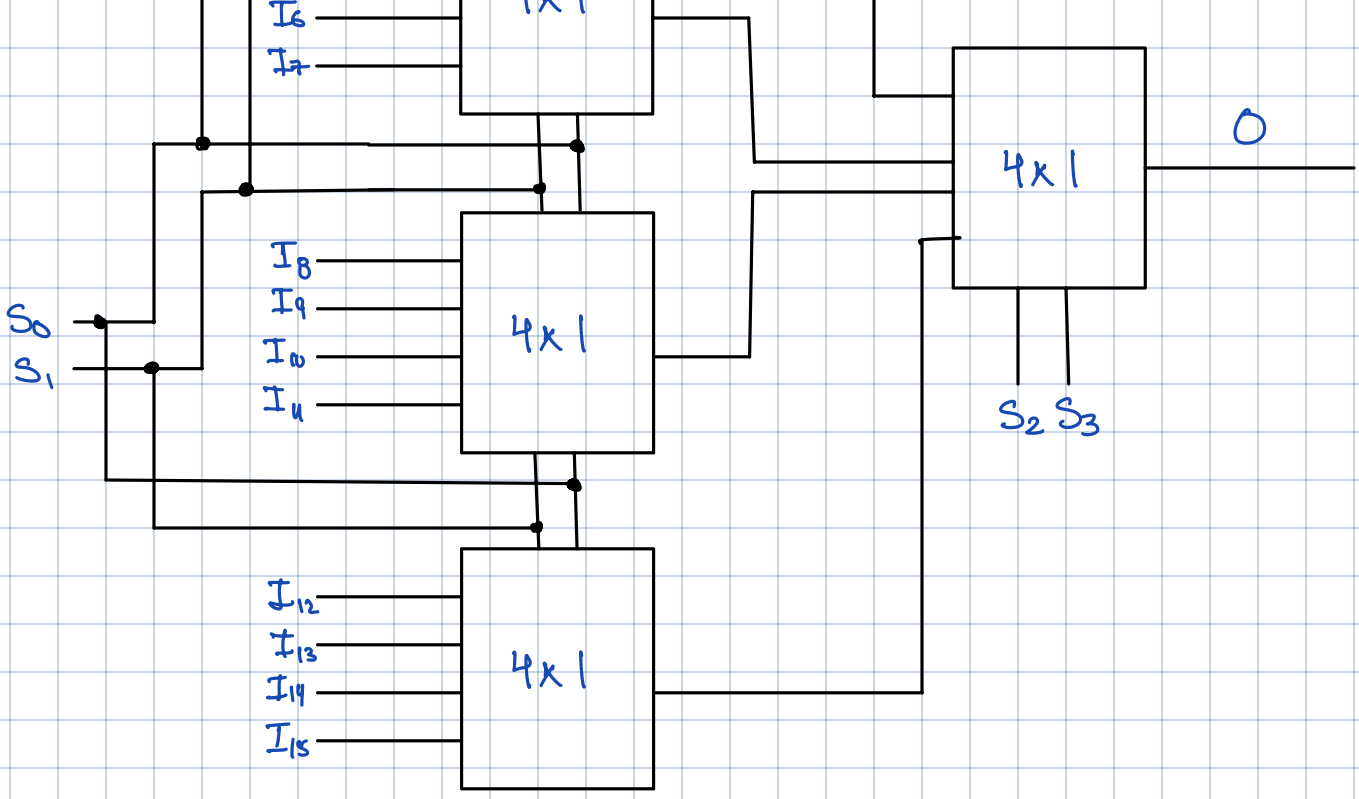
8x1 mux using 4x1





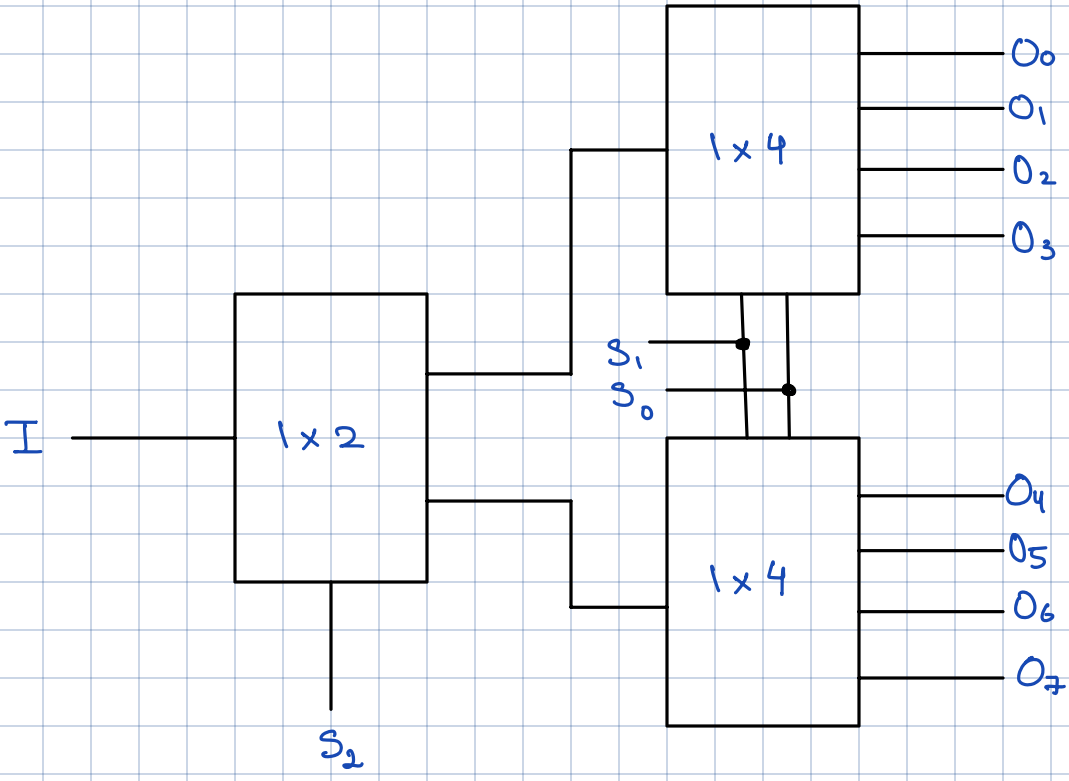
16x1 mux using 4x1



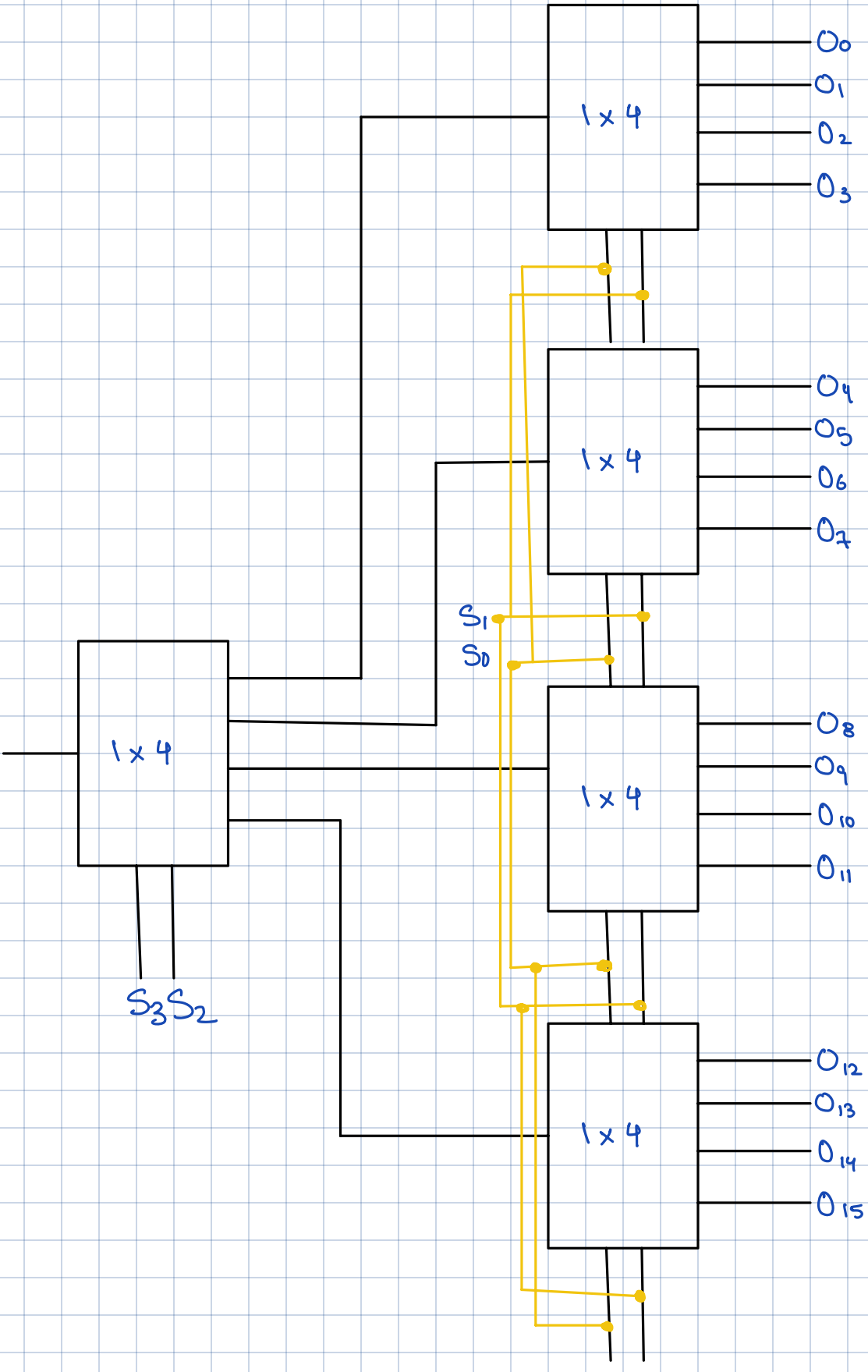


De-Multiplexer:

1x8 DeMux using 1x4



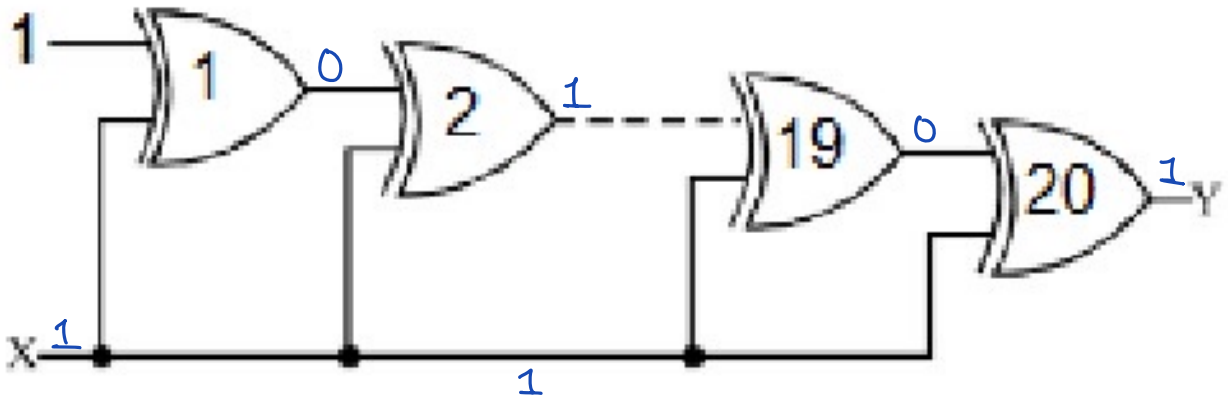
16x1 DeMux using 4x1 DeMux



Mid 2021

Section: 01

Q1.



X	Y
0	0
1	1

Q2.

(ii)

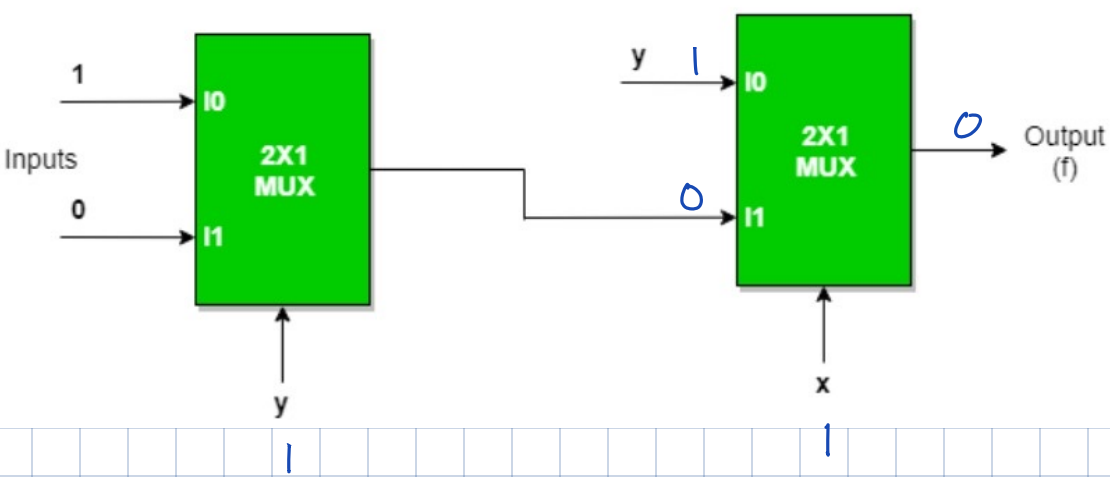
2	254	
2	127	0
2	63	1
2	31	1
2	15	1
2	7	1
2	3	1
2	1	1

0 1 1 1 1 1 1 1 0

(i)

$$\begin{array}{r} 0\,1\,1\,1\,1\,1\,1\,1\,0 \\ \quad\quad\quad\quad\quad\quad\quad 1 \\ 1\,0\,0\,0\,0\,0\,0\,0\,1 \\ + \quad\quad\quad\quad\quad\quad\quad 1 \\ \hline 1\,0\,0\,0\,0\,0\,0\,1\,0 \end{array}$$

Q3.



X	Y	f
0	0	0
0	1	1
1	0	1
1	1	0

X \ Y	0	1
0	0	1
1	1	0

$G1 = \bar{X}Y$

$G2 = X\bar{Y}$

$f = \bar{X}Y + X\bar{Y}$

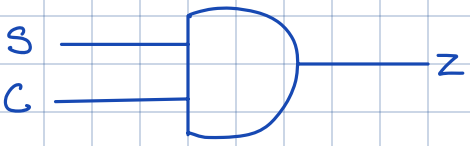
$= X \oplus Y$

Q4.

S	C	Z
0	0	0
0	1	0
1	0	0
1	1	1

X \ Y	0	1
0	0	0
1	0	1

$Z = SC$



Section :02

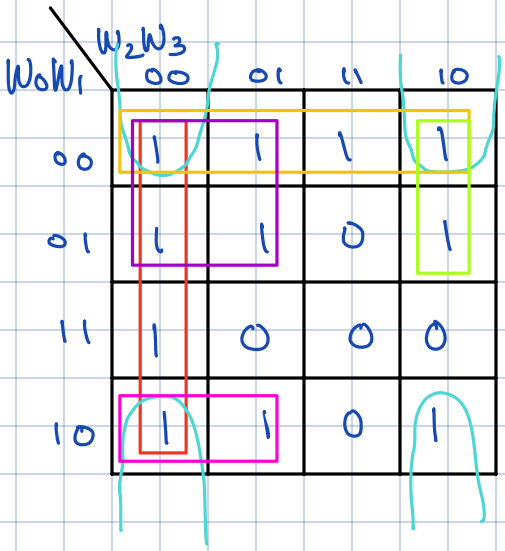
Q1.

N_0	N_1	N_2	N_3	A
0	0	0	0	1
0	0	0	1	1
0	0	1	0	1
0	0	1	1	1
0	1	0	0	1
0	1	0	1	1
0	1	1	0	1
0	1	1	1	0
1	0	0	0	1
1	0	0	1	1
1	0	1	0	1
1	0	1	1	0
1	1	0	0	1
1	1	0	1	0
1	1	1	0	0

wheel break = 0
wheel work = 1

Alarm work = 1
Alarm stop = 0

1 1 1 1 0



$R5 = \overline{W_0}\,\overline{W_2}$ $\quad R6 = \overline{W_0}\,W_2\,\overline{W_3}$

$R1 = \overline{W_0}W_1$

$R2 = \overline{W_2}\overline{W_3}$

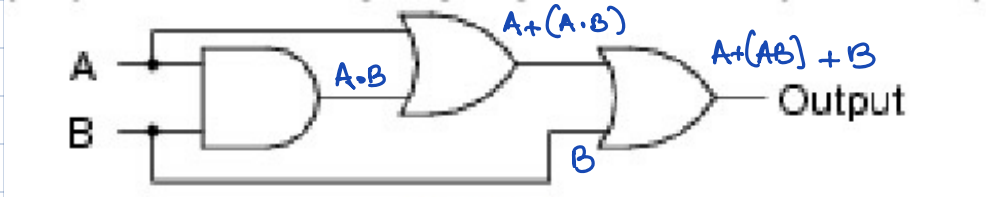
$R3 = \overline{W_1}\,\overline{W_3}$

$R4 = \overline{W_1}W_0\,\overline{W_2}$

$$A = \overline{W_0}\overline{W_3}W_2 + \overline{W_0}W_2 + \overline{W_0}W_3 + \overline{W_2}\overline{W_3} + \overline{W_1}\,\overline{W_3} + W_0\overline{W_1}\,\overline{W_2}$$

Q2.

A.

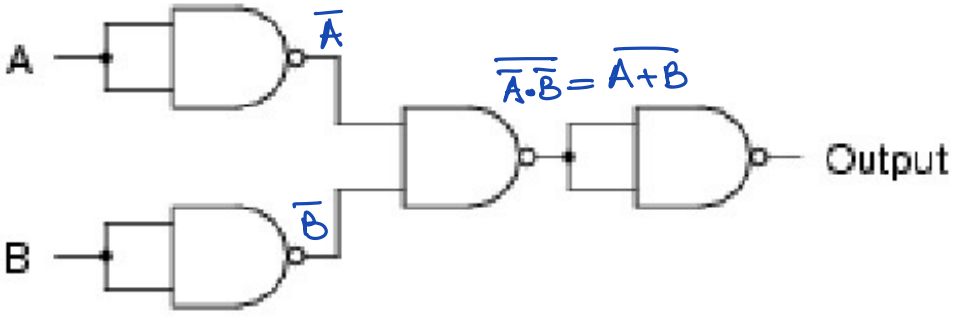


Circuit 1

$A + AB + B$

$A(1 + B) + B$

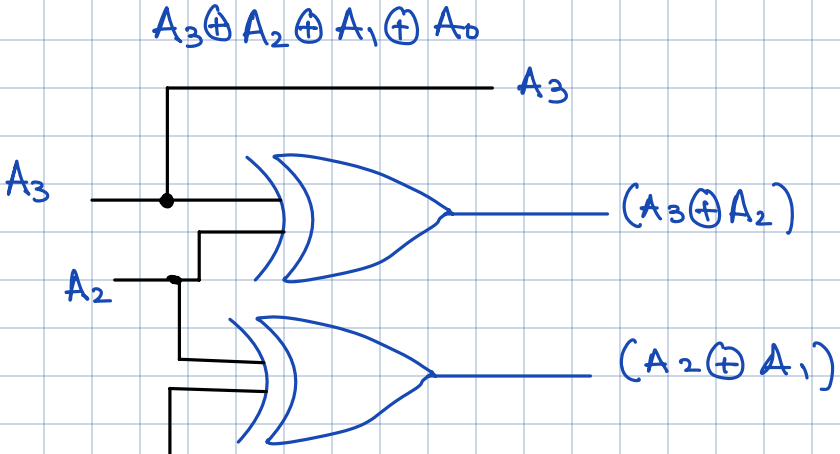
$A + B$

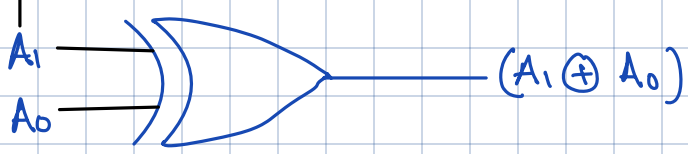


$\overline{A+B} = \overline{A}\,\overline{B}$

$$\overline{\overline{A} + \overline{B}} = \overline{A+B}$$

B:





Q3.

	x	y	z	A	B	C	
0	0	0	0	0	0	1	1
1	0	0	1	0	1	0	2
2	0	1	0	0	1	1	3
3	0	1	1	1	0	0	4
4	1	0	0	0	1	1	3
5	1	0	1	1	0	0	4
6	1	1	0	1	0	1	5
7	1	1	1	1	1	0	6

For A:

xy \ z	0	1
00	0	0
01	0	1
11	1	1
10	0	1

R1 = YZ

R2 = XZ

R3 = XY

A = XY + YZ + XZ

For B:

xy \ z	0	1
00	0	1
01	1	0
11	0	1
10	1	0

R1 = $\bar{X}\bar{Y}Z$

R2 = $\bar{X}Y\bar{Z}$

R3 = XYZ

R4 = $X\bar{Y}\bar{Z}$

For C:

xy \ z	0	1
00	1	0
01	1	0
11	1	0
10	1	0

R1 = $\bar{Z}$

C = $\bar{Z}$

B = $\bar{X}\bar{Y}Z + \bar{X}Y\bar{Z} + XYZ + X\bar{Y}\bar{Z}$

Fall 2022

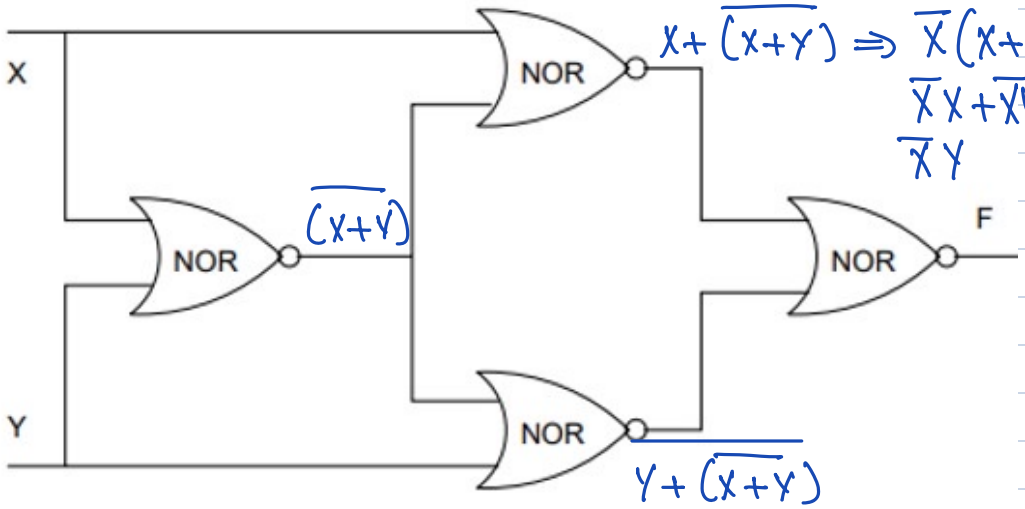
Section 01:

Q1.

X_3	X_2	X_1	X_0	ODD	EVEN	+ev	-ev
0	0	0	0	0	1	1	0
0	0	0	1	1	0	1	0
0	0	1	0	0	1	1	0
0	0	1	1	1	0	1	0
0	1	0	0	0	1	1	0
0	1	0	1	1	0	1	0
0	1	1	0	0	1	1	0
0	1	1	1	1	0	1	0
1	0	0	0	0	1	0	1

1	0	1	1	1	0	0	1
1	0	0	0	0	1	0	1
1	0	0	1	1	0	0	1
1	1	1	0	0	1	0	1
1	1	1	1	1	0	0	1
1	1	0	0	0	1	0	1
1	1	0	1	1	0	0	1

Q3.



$\overline{X+\overline{(X+Y)}} \Rightarrow \overline{X}(X+Y)$

$\overline{X}X+\overline{X}Y$

$\overline{X}Y$

$\overline{(X\overline{Y}+\overline{X}Y)}$

$(\overline{X}\,\overline{\overline{Y}})(\overline{\overline{X}}\,\overline{Y})$

$(\overline{X}+Y)(X+\overline{Y})$

$\overline{X}X+\overline{X}\overline{Y}+XY+Y\overline{Y}$

$\overline{X}\overline{Y}+XY$

$\overline{Y+\overline{(X+Y)}}$

$\overline{Y}(X+Y)$

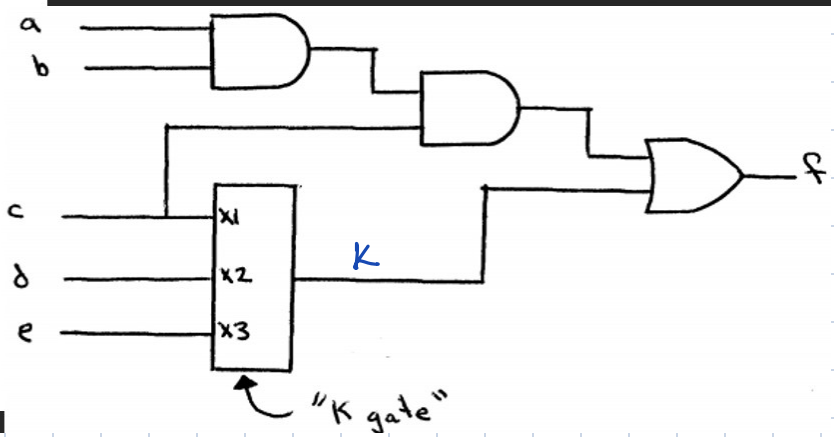
$X\overline{Y}+Y\overline{Y}$

$X\overline{Y}$

Q5.

Truth table for the "K gate":

X1	X2	X3	K
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	0

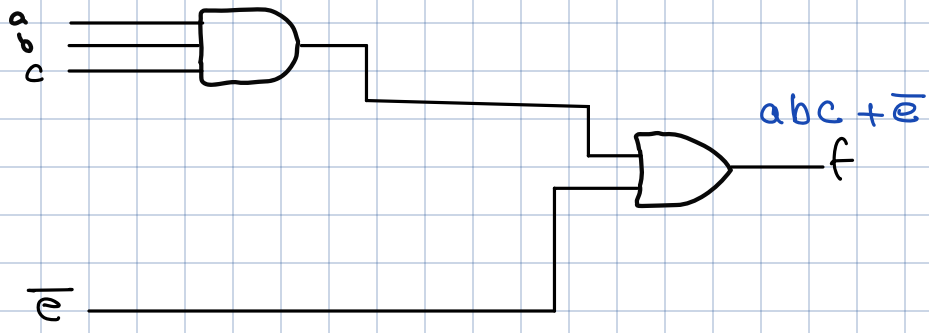


For K =

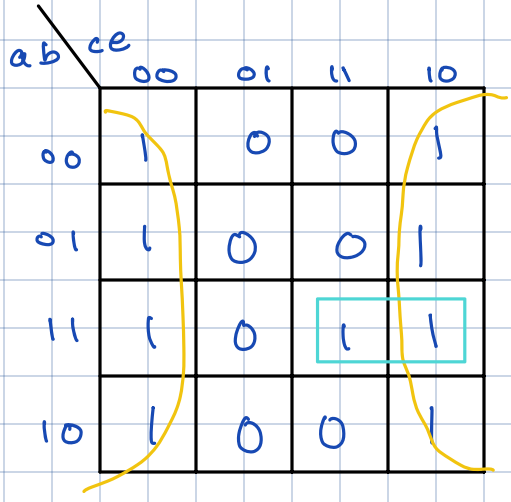
X_1X_2 \ X_3	0	1
00	1	0
01	1	0
11	1	0
10	1	0

$G3 = \overline{X_3}$

$K = \overline{X_3}$



a	b	c	ē	abc+ē
0	0	0	1	1
0	0	0	0	0
0	0	1	1	1
0	0	1	0	0
0	1	0	1	1
0	1	0	0	0
0	1	1	1	1
0	1	1	0	0
1	0	0	1	1
1	0	0	0	0
1	0	1	1	1
1	0	1	0	0
1	1	0	1	1
1	1	0	0	0
1	1	1	1	1
1	1	1	0	1

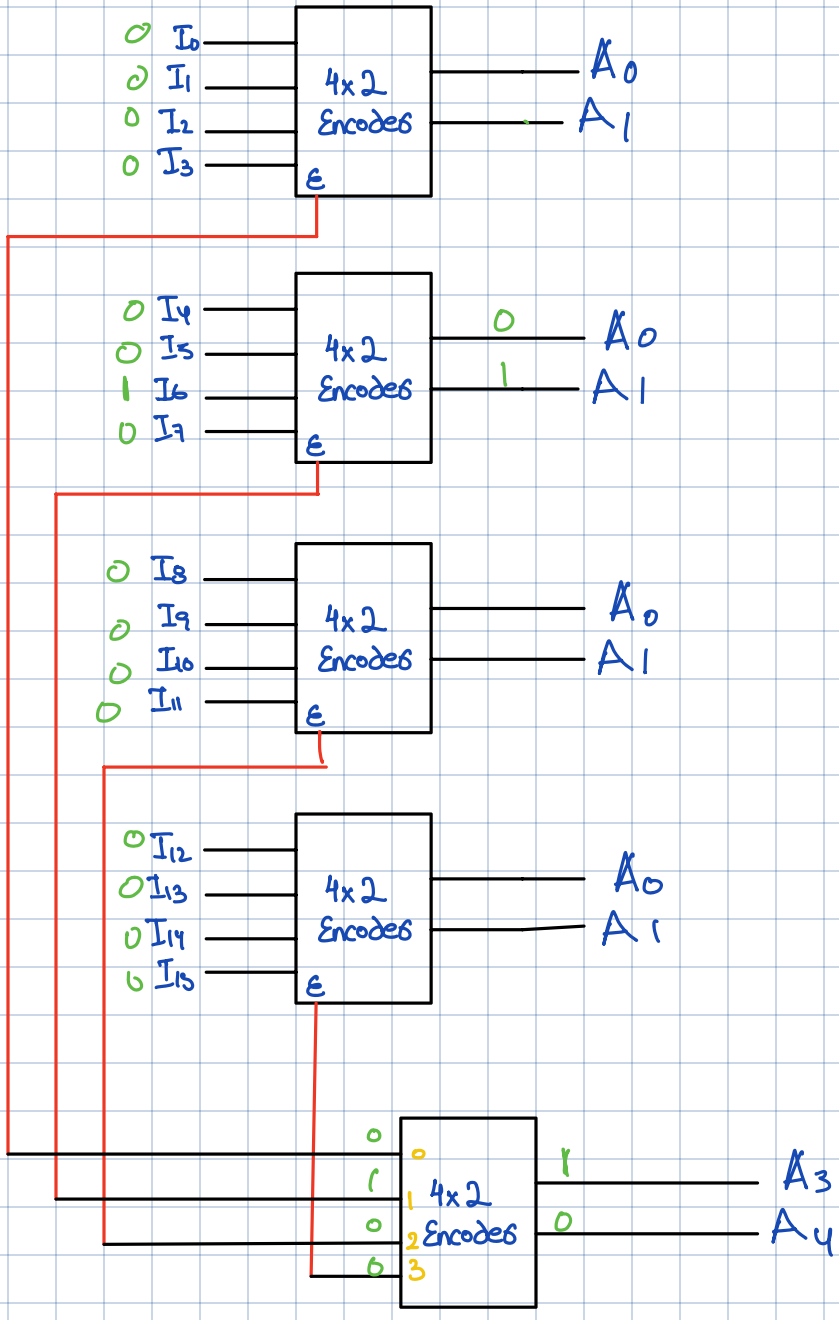


$R1 = \bar{e}$

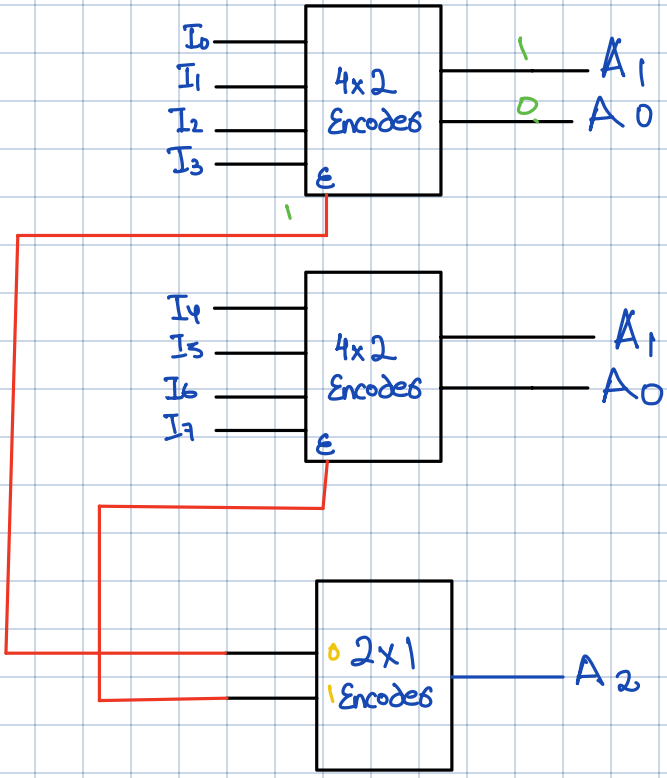
$R2 = abc$

$abc + \bar{e}$

16 x 4 Encoder using 4 x 2 encoder


0 I0
0 I1
0 I2
0 I3
E
4x2 Encoder
A0
A1
0 I4
0 I5
1 I6
0 I7
E
4x2 Encoder
0
1
A0
A1
0 I8
0 I9
0 I10
0 I11
E
4x2 Encoder
A0
A1
0 I12
0 I13
0 I14
0 I15
E
4x2 Encoder
A0
A1
0
1
0
0
0
1
2
3
4x2 Encoder
1
0
A3
A4

8x3 encoder using 4x2 encoder



A_2	A_1	A_0
0	0	0
0	0	1
0	1	0
0	1	1
1	0	0
1	0	1
1	1	0
1	1	1