21-CP-26 M. Ibrahim

Q No 1

Design following basic gates 2x1 MUX only?

a) Inverter.

Truth table :- Not gate

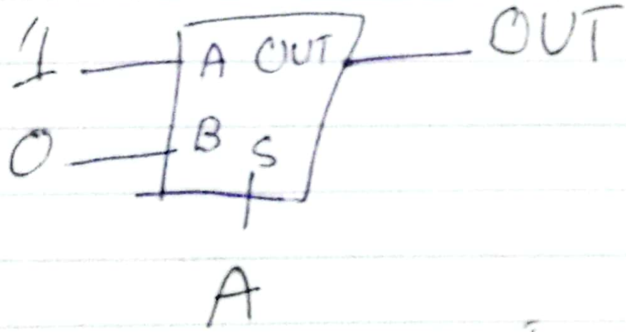
A	OUT
0	1
1	0

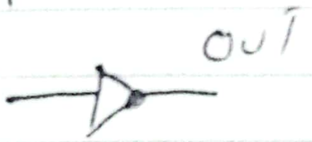
Inverted

S = 0
OUT = 1
S = 1
OUT = 0

NOT Gate

A = Select





Truth table 2x1

S	A	B	Out
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1

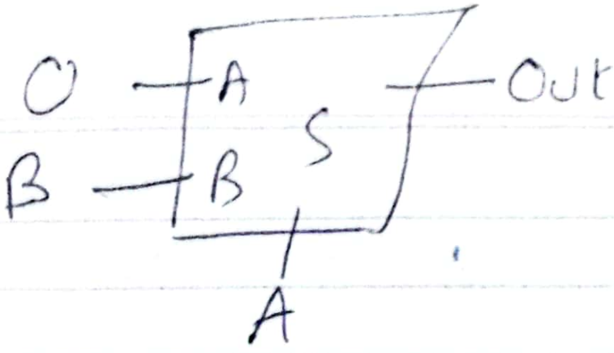
b) 2-input and gate

Truth table And gate

A	B	Out
0	0	0
0	1	0
1	0	0
1	1	1

] Out = 0 when A = 0

] OUT = B when A = 1

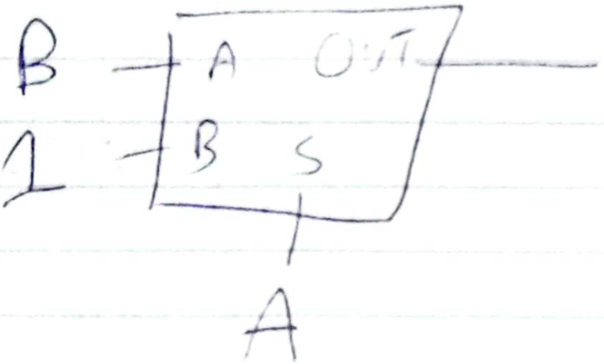


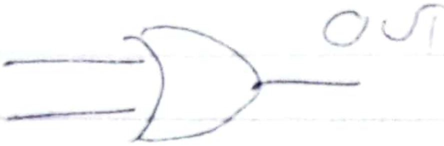
2-input or gate

Truth table

A	B	OUT
0	0	0
0	1	1
1	0	1
1	1	1

OUT = B when A = 0
OUT = 1 when A = 1

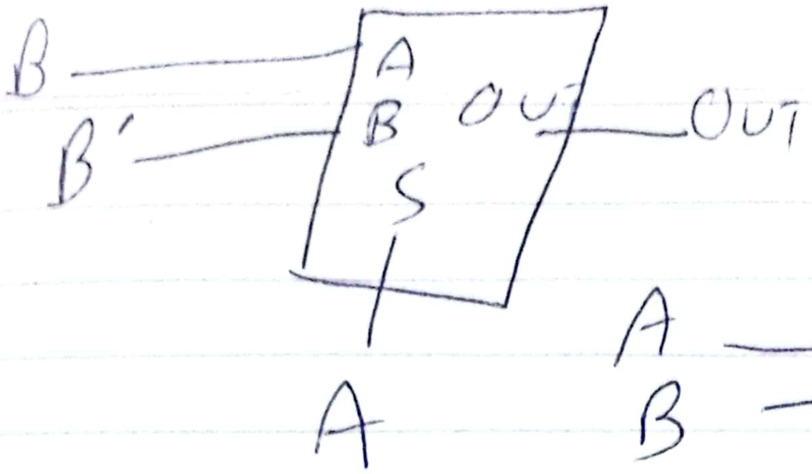


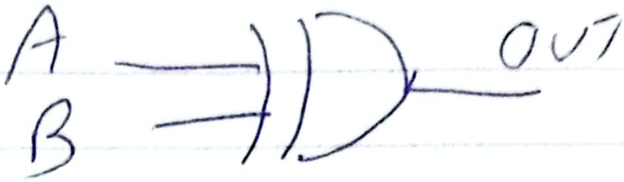


2-input xor gate

A	B	OUT
0	0	0
0	1	1
1	0	1
1	1	0

OUT = B when A = 0
OUT = B' when A = 1



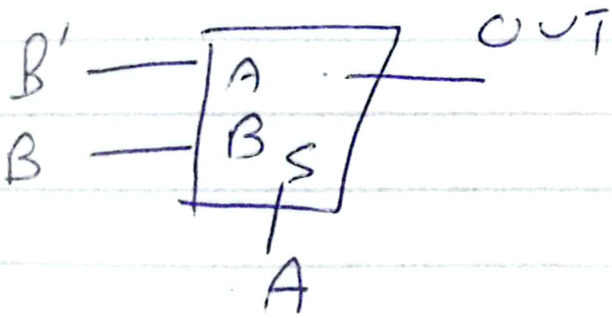


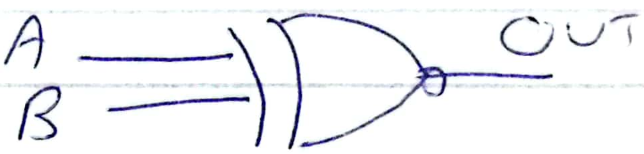
2-input XNOR

A	B	OUT
0	0	1
0	1	0
1	0	0
1	1	1

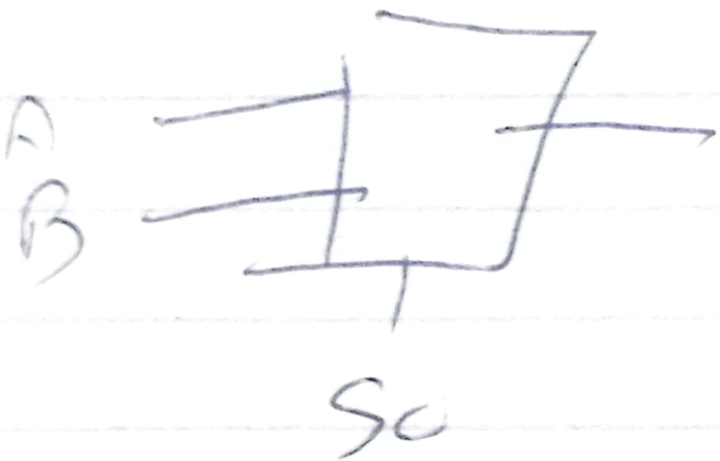
OUT = B' when A = 0

OUT = B when A = 1



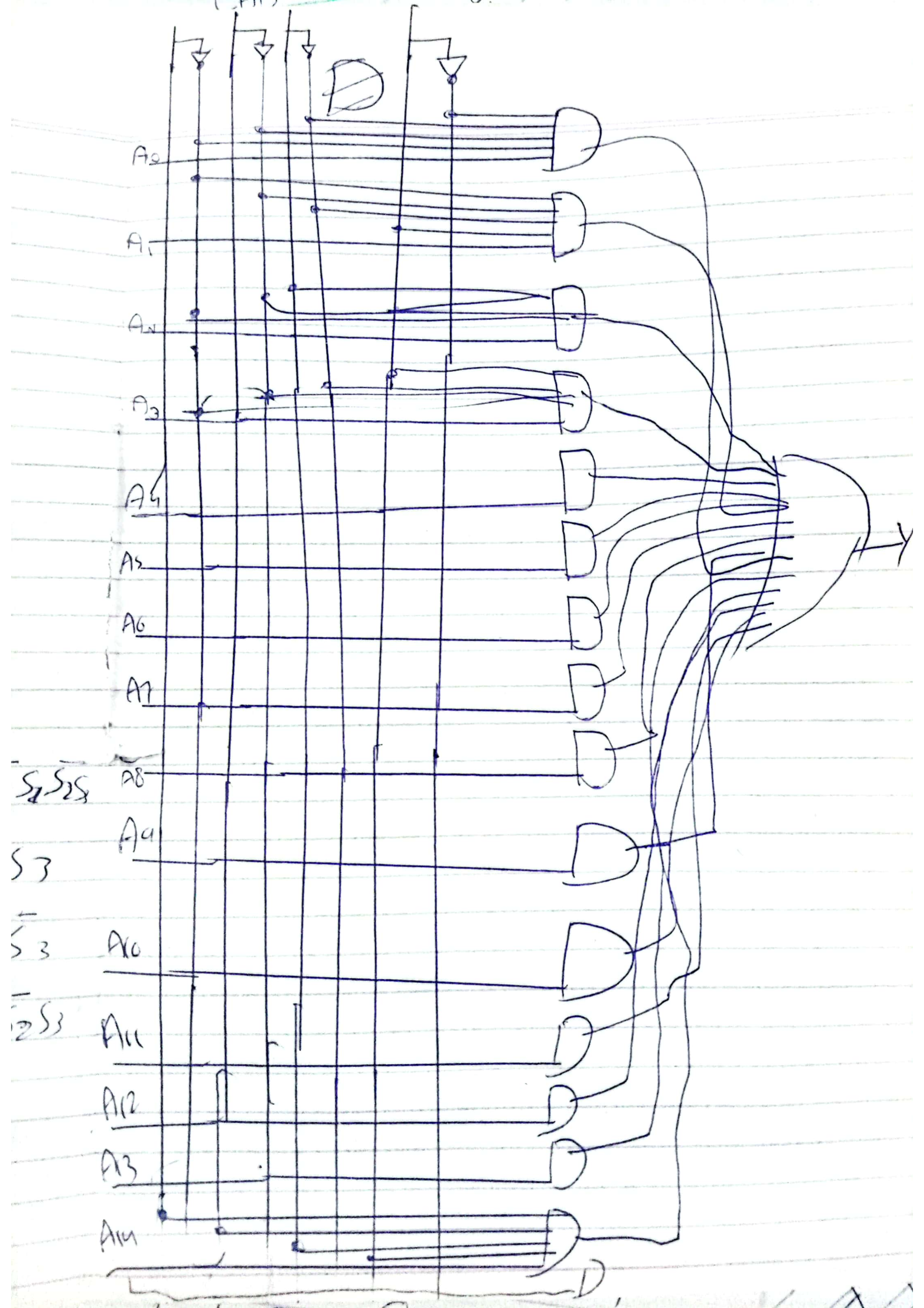


Task 2 16x1 using 2x1

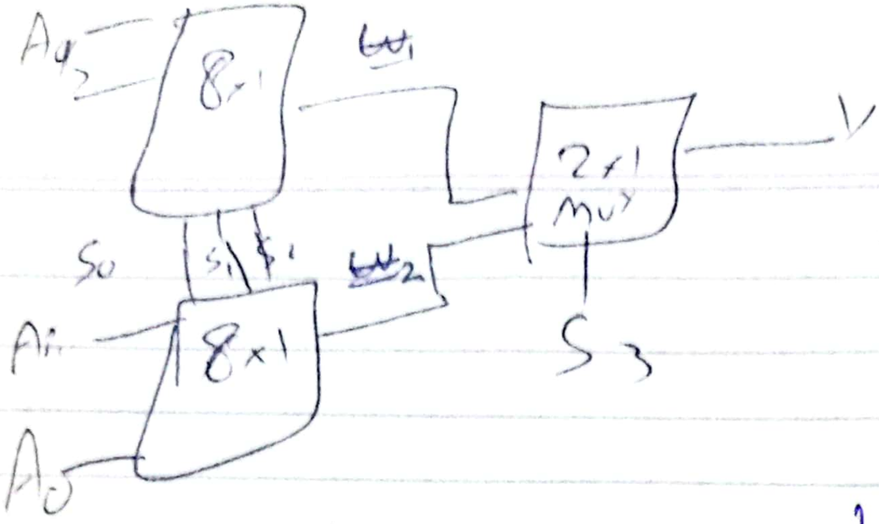


Inputs				Outps
S_0	S_1	S_2	S_3	Y
0	0	0	0	A_0
0	0	0	1	A_1
0	0	1	0	A_2
0	0	1	1	A_3
0	1	0	0	A_4
0	1	0	1	A_5
0	1	1	0	A_6
0	1	1	1	A_7
1	0	0	0	A_8
1	0	0	1	A_9
1	0	1	0	A_{10}
1	0	1	1	A_{11}
1	1	0	0	A_{12}
1	1	0	1	A_{13}
1	1	1	0	A_{14}
1	1	1	1	A_{15}

$$Y = A_0 \bar{S_0} \bar{S_1} \bar{S_2} \bar{S_3} + A_1 \bar{S_0} \bar{S_1} \bar{S_2} S_3$$
$$+ A_2 \bar{S_0} \bar{S_1} S_2 \bar{S_3} + A_3 \bar{S_0} \bar{S_1} S_2 S_3 + A_4 \bar{S_0} S_1 \bar{S_2} \bar{S_3}$$
$$+ A_5 \bar{S_0} S_1 \bar{S_2} S_3 + A_6 \bar{S_0} S_1 S_2 \bar{S_3} + A_7 \bar{S_0} S_1 S_2 S_3$$
$$+ A_8 S_0 \bar{S_1} \bar{S_2} \bar{S_3} + A_9 S_0 \bar{S_1} \bar{S_2} S_3 + A_{10} S_0 \bar{S_1} S_2 \bar{S_3}$$
$$+ A_{11} S_0 \bar{S_1} S_2 S_3 + A_{12} S_0 S_1 \bar{S_2} \bar{S_3} + A_{13} S_0 S_1 \bar{S_2} S_3$$
$$+ A_{14} S_0 S_1 S_2 \bar{S_3} + A_{15} S_0 S_1 S_2 S_3$$

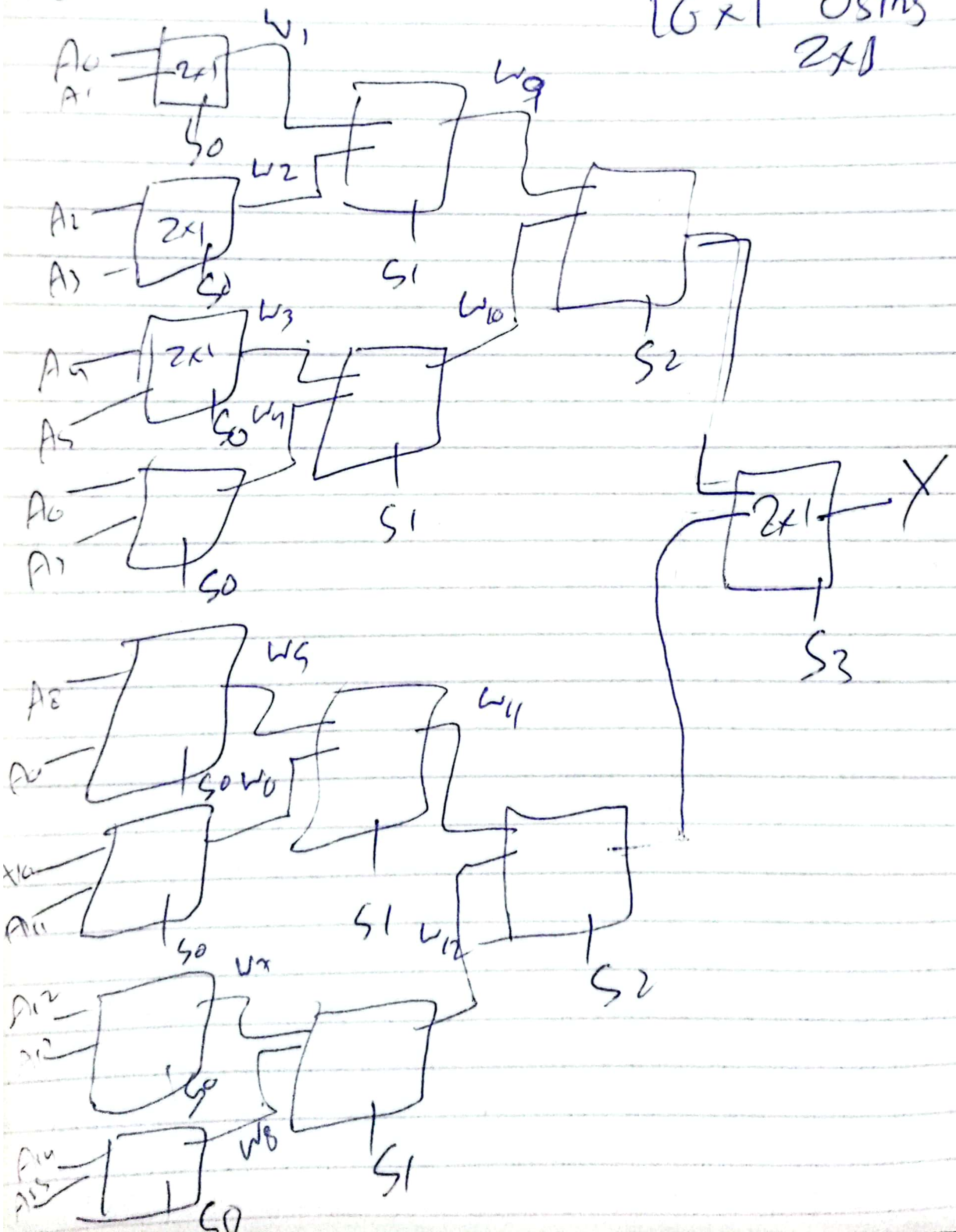


A0
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A11
A12
A13
A14
Y
$S_1 S_2 S_3$
S_3
S_3
$S_2 S_3$



16 x 1 using 8x1

16x1 using 2x1



Task 3

Task 3

3-bit comparator

Truth Table

A0	A1	A2	B0	B1	B2	G (A>B)	L (A<B)	E (A=B)
0	0	0	0	0	0	0	0	1
0	0	0	0	0	1	0	1	0
0	0	0	0	1	0	0	1	0
0	0	0	0	1	1	0	1	0
0	0	0	1	0	0	0	1	0
0	0	0	1	0	1	0	1	0
0	0	0	1	1	0	0	1	0
0	0	0	1	1	1	0	1	0
0	0	1	0	0	0	1	0	0
0	0	1	0	0	1	0	0	1
0	0	1	0	1	0	0	1	0
0	0	1	0	1	1	0	1	0
0	0	1	1	0	0	0	1	0
0	0	1	1	0	1	0	1	0
0	0	1	1	1	0	0	1	0
0	0	1	1	1	1	0	1	0
0	1	0	0	0	0	1	0	0
〃	〃	〃	0	0	1	1	0	0
〃	〃	〃	0	1	0	0	0	1
〃	〃	〃	0	1	1	0	0	1
〃	〃	〃	1	0	0	0	0	1
〃	〃	〃	1	0	1	0	0	1
〃	〃	〃	1	1	0	0	0	1
0	1	0	1	1	1	0	0	1

E

$A = B$

A_2		A_1		A_0
$\parallel$	&	$\parallel$	&	$\parallel$
B_2		B_1		B_0

$B \quad A$
$0 \quad 1$
$\to A \cdot \bar{B}$

XNOR

: ID

$A_2 \Rightarrow \bar{A}_2 \bar{B}_2 + A_2 B_2$

$A_2 \oplus B_2$

$A_1 \Rightarrow A_1 \oplus B_1$ $\qquad A_0 = B_0$

$A_0 \Rightarrow A_0 \oplus B_0$

$E = (A_1 \oplus B_1) \cdot (A_2 \oplus B_2) \cdot (A_0 \oplus B_0)$

G $\underline{A > B}$

3 case

$\cancel{(1)\ A_2 = B_2,\ A_1 = B_1,\ A_0 > B_0}$

$\cancel{(A_2 \oplus B_2) \cdot (A_1 \oplus B_1) \cdot (A_0 \cdot \bar{B}_0)}$

$\cancel{A_2 = 1 \quad B_2 = 0}$

1) $A_2 > B_2 \quad A_2 = 1 \quad B_2 = 0$

$A_2 \cdot \bar{B}_2$

b) $A_2 = B_2$, $A_1 > B_1$

$(A_2 \odot B_2) \cdot (A_1 \cdot \bar{B}_1)$

c) $A_2 = B_2$, $A_1 = B_2$, $A_0 > B_0$

$(A_2 \odot B_2) \cdot (A_1 \odot B_1) \cdot (A_0 \cdot \bar{B})$

L $A < B$

a) $A_2 < B_2$ $A_2 = 0$ $B_2 = 1$

$\bar{A}_2 \cdot B_2$

b) $A_2 = B_2$, $A_1 < B_1$

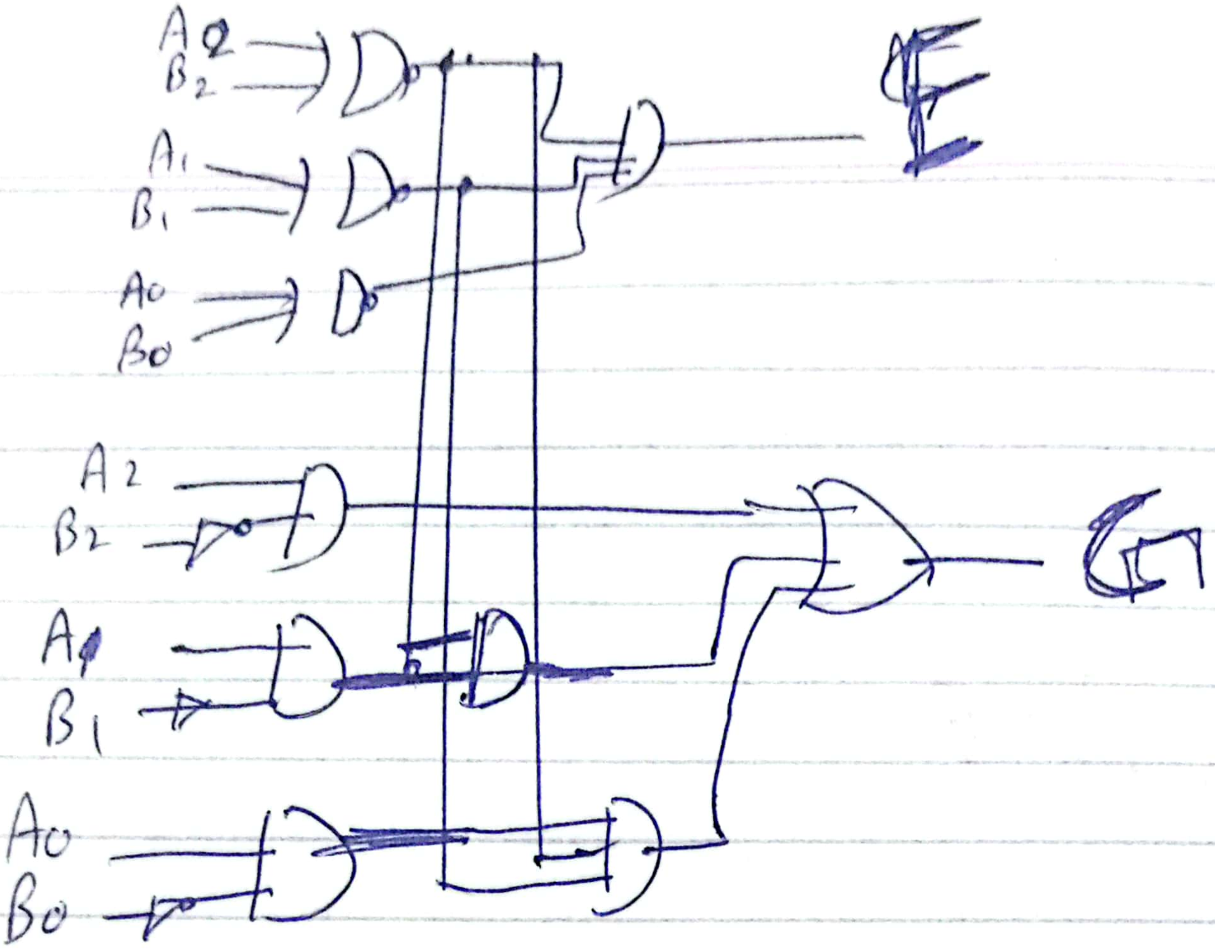
$(A_2 \odot B_2) \cdot \bar{A}_1 B_1$

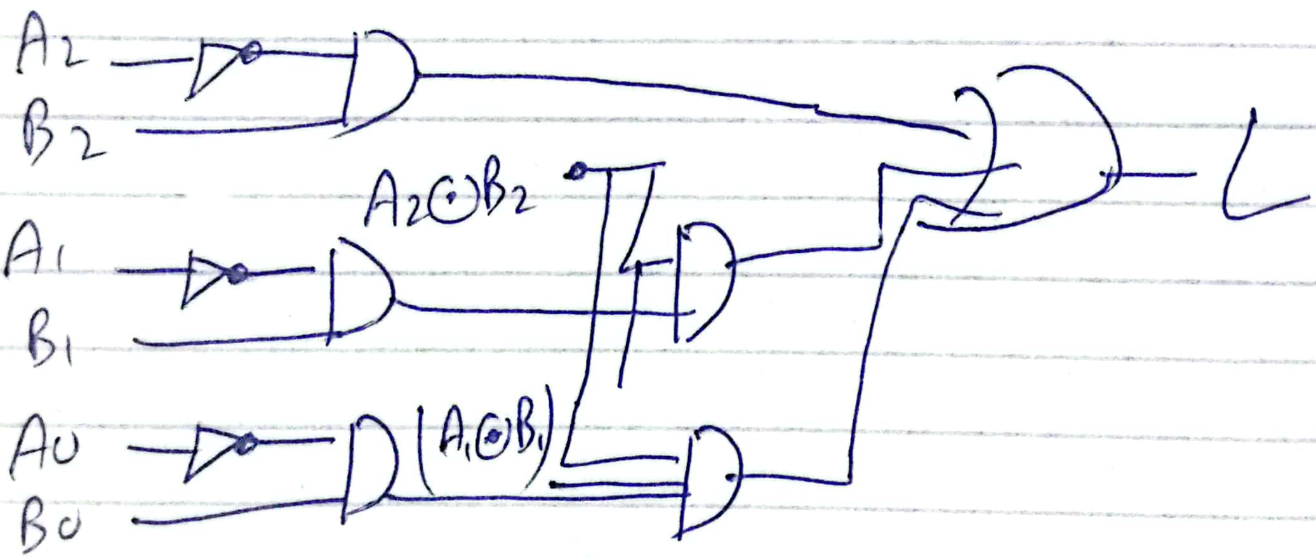
c) $A_2 = B_2$, $A_1 = B_1$, $A_1 < B_1$

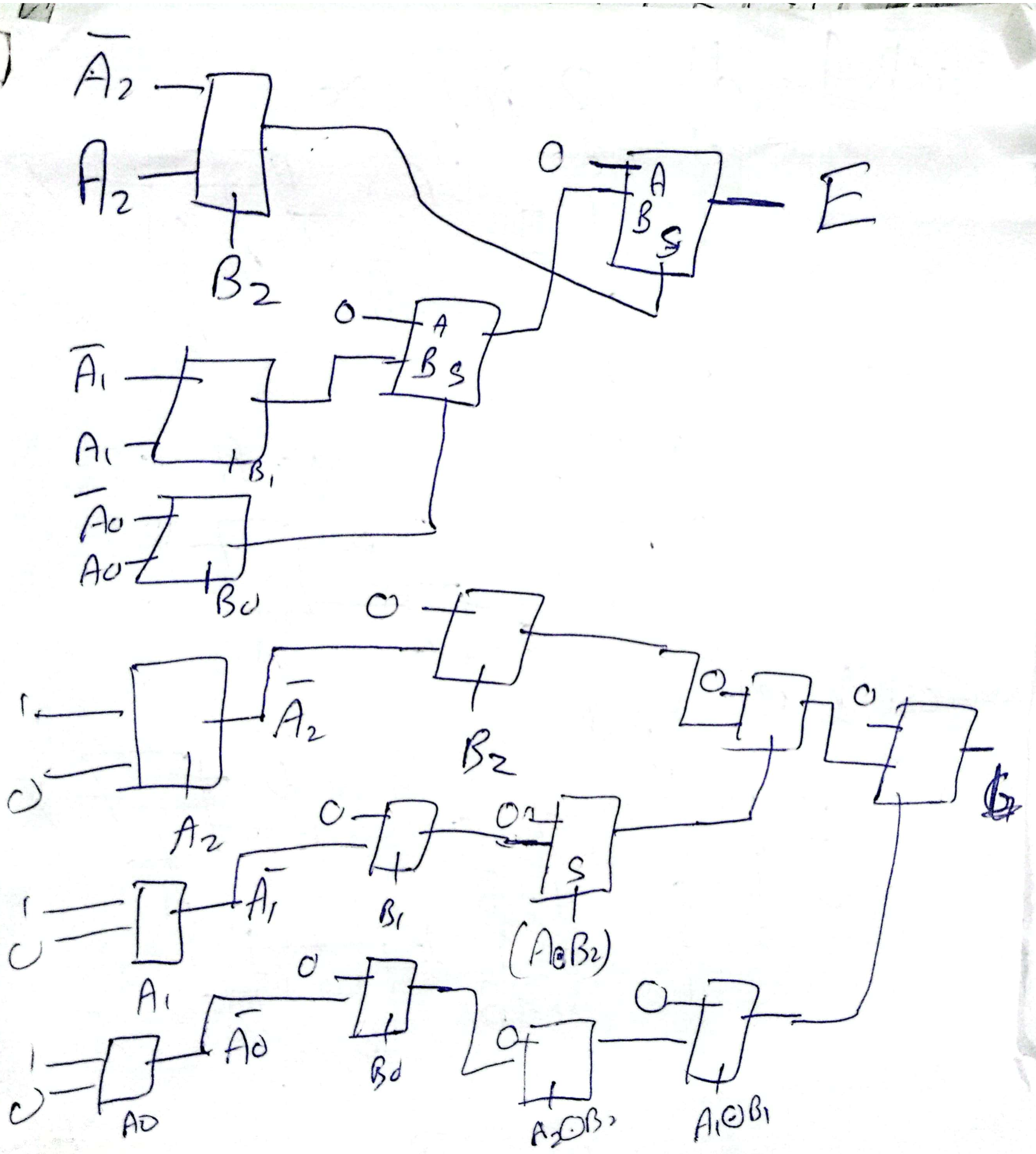
$(A_2 \odot B_2) \cdot (A_1 \odot B_1) \cdot \bar{A}_1 \cdot B_1$

$L = \bar{A}_2 \cdot B_2 + (A_2 \odot B_2) \cdot \bar{A}_1 B_1$

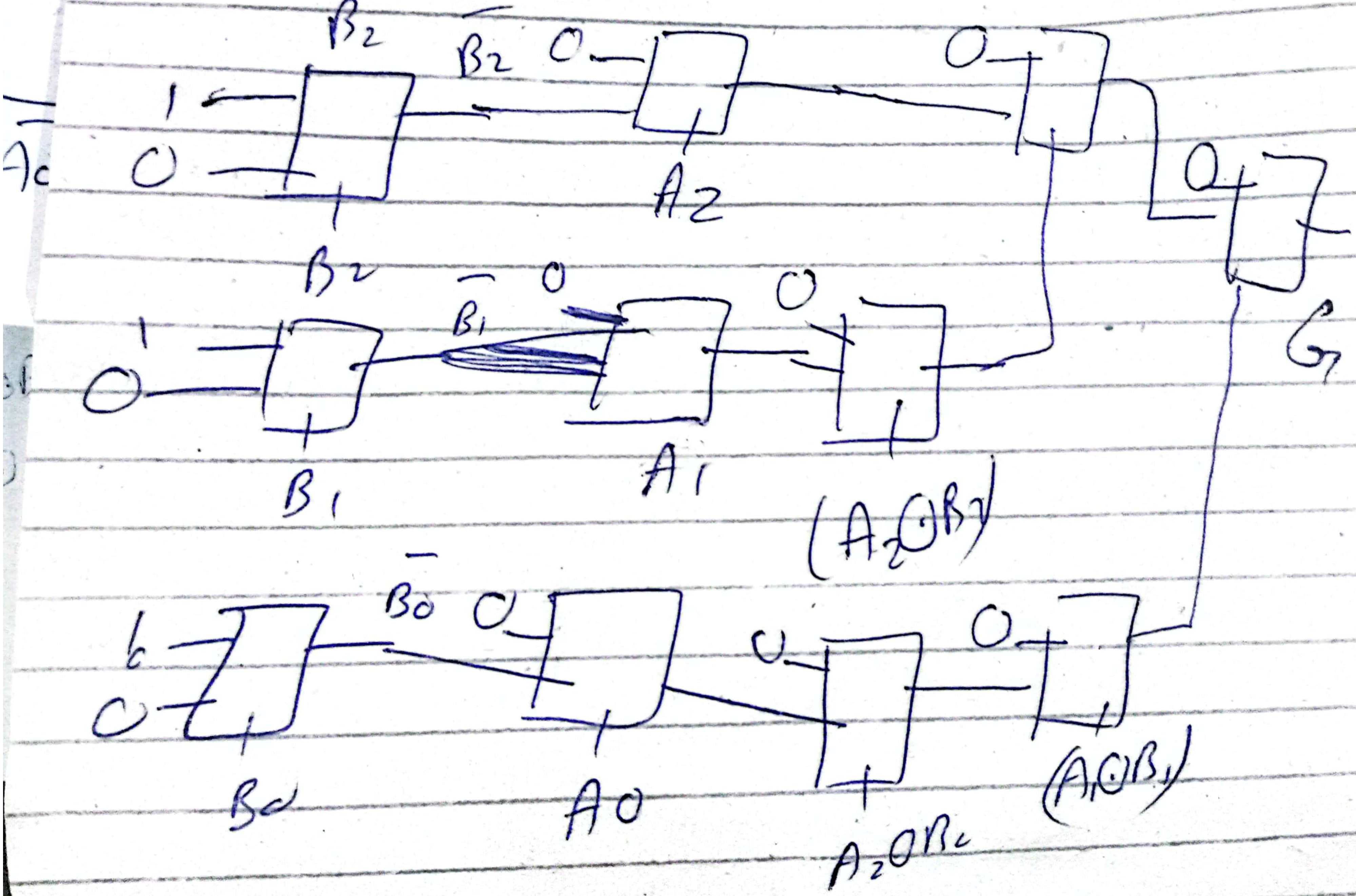
$+ (A_2 \odot B_2) \cdot (A_1 \odot B_1) \cdot \bar{A}_1 \cdot B_1$


A2
B2
A1
B1
A0
B0
E
G


A2
B2
A1
B1
A0
B0
A2⊙B2
(A1⊙B1)
L



$\bar{A}_2$
A_2
B_2
0
A
B
S
E
0
A
B
S
$\bar{A}_1$
A_1
B_1
$\bar{A}_0$
A_0
B_0
0
1
0
$\bar{A}_2$
A_2
B_2
0
0
G
0
0
S
1
0
$\bar{A}_1$
A_1
B_1
$(A_2 \odot B_2)$
0
1
0
$\bar{A}_0$
A_0
B_0
0
0
$A_2 \odot B_2$
$A_1 \odot B_1$



B_2
$\bar{B}_2$
A_2
B_2
$\bar{B}_1$
B_1
A_1
$(A_2 \odot B_2)$
$\bar{B}_0$
B_0
A_0
$A_2 \odot B_2$
$(A_1 \odot B_1)$
G

Q. No 4 Even Parity

A	B	C	D	?
0	0	0	0	1
0	0	0	1	0
0	0	1	0	0
0	0	1	1	1
0	1	0	0	0
0	1	0	1	1
0	1	1	0	1
0	1	1	1	0
1	0	0	0	0
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
1	1	1	1	1

AB \ CD	00	01	11	10
00	1		1	
01		1		1
11	1		1	
10		1		1

$$P = \bar{A}\bar{B}\bar{C}\bar{D} + \bar{A}\bar{B}CD + \bar{A}B\bar{C}D$$

$$+ \bar{A}BC\bar{D} + AB\bar{C}\bar{D} + ABCD$$

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

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

$$X \odot Y = XY + \bar{X}\bar{Y}$$

$$X \odot Y = \overline{X \oplus Y}$$

$= \bar{A}\bar{B}(\bar{C}\bar{D} + CD) + \bar{A}B(\bar{C}D + C\bar{D})$

$+ AB(\bar{C}\bar{D} + CD) + A\bar{B}(\bar{C}D + C\bar{D})$

$= \bar{A}\bar{B}(C \odot D) + \bar{A}B(C \oplus D)$

$+ AB(C \odot D) + A\bar{B}(C \oplus D)$

$= (C \odot D)(\bar{A}\bar{B} + AB) + (C \oplus D)(\bar{A}B + A\bar{B})$

$= (C \odot D)(A \odot B) + (C \oplus D)(A \oplus B)$

$= (C \odot D)(A \odot B) + (\overline{C \odot D})(\overline{A \odot B})$

$\Rightarrow Y.X + \bar{Y}.\bar{X}$ $\qquad A \odot B = Y$

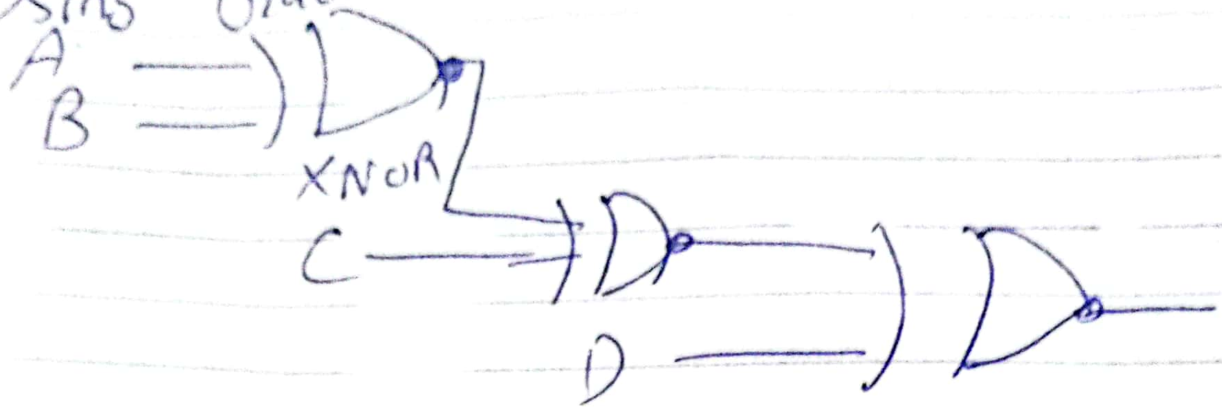
$\Rightarrow XY + \bar{X}\bar{Y}$ $\qquad C \odot D = Y$

$= X \odot Y$ $\qquad$ XNOR

$= A \odot B \odot C \odot D$

$A \odot B \odot C \odot D$

Using Gates



Using MUX