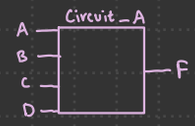
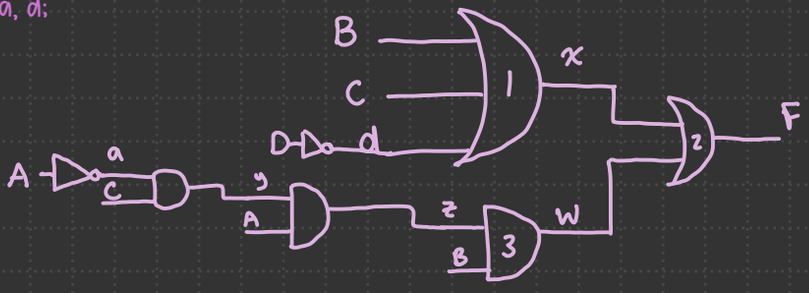
Title : hw #4 Gianna Galard ☺ Date : / /

#1

a)

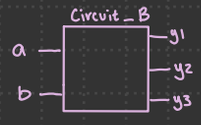
```
module Circuit_A (A, B, C, D, F);
input A, B, C, D;
output F;
wire w, x, y, z, a, d;
or (x, B, C, d);
and (y, a ,C);
and (w, z ,B);
and (z, y, A);
or (F, x, w);
not (a, A);
not (d, D);
endmodule
```

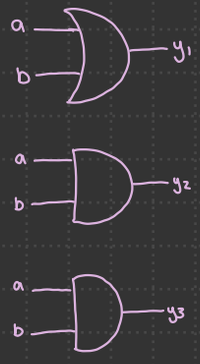




b)

```
module Circuit_B (y1, y2, y3, a, b);
output y1, y2, y3;
input a, b;
assign y1 = a || b;
and (y2, a, b);
assign y3 = a && b;
endmodule
```

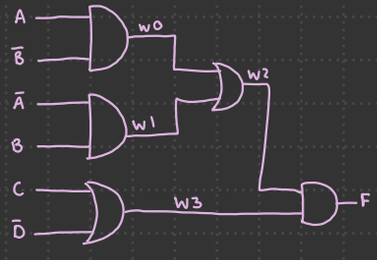




#2

a)

```
module Circuit(F,A_bar, B, B_bar, C, D_bar);
input A,A_bar,B,B_bar,C,D_bar;
output F;
Wire w0,w1,w2,w3;
and(w0,A,B_bar);
assign w1=A_bar&&B;
or(w3,C,D_bar);
assign w2=w0||w1;
assign F=w2&&w3
```



b)

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

```
module Circuit(Z,A,B_bar,C,C_bar,D)
input A,B_bar,C,C_bar,D;
output Z;
assign Z=(A||B_bar)&&C_bar&&(C||D)
endmodule
```

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	M	A	B	S	C	V
a)	0	1100	1000	0100	1	1
b)	1	0111	0110	0001	1	0
c)	1	0000	0001	1111	0	0
d)	0	0101	1010	1111	0	0

#3

A: 1100 → a unsigned = 8+4 = 12 (look @ carry)
→ b signed = -8+4 = -4 (look @ overflow)

a)

A: 1100 → 1100 = $-2^3+2^2 = -4$

+B: 1000

(1)0100 → unsigned = $\frac{12}{8}$ → +4 invalid (c=1)

→ Signed = +4, -4, -8, -12 invalid (v=1)

b) 0111 − 0110 = 0001

0110 → 1001 + 1 = 1010

0111 + 1010 = (1)0001

c4=1, c3=1, 1⊕1=0=v

c) 0000 + 1111 = 0 1111 → -1

0001 + 1110 = 1111 → -1

c4⊕c3=v, 0⊕0=0=v

d) 0101 + 1010 = 0 1111

5 = +10, -6 = -1, 15 = -1

c

0⊕0=0=v

#4 a) worst case prop delay

$T_{crit} = 15+15 = 30\,ns$

#5 4 input 2 output (use 2 kmap)

$F = \bar{A}\cdot\overline{\bar{A}\cdot D}\cdot(\bar{A}+BC)$

$F = \bar{A}\cdot(A+\bar{D})\cdot(\bar{A}+BC)$

$F = \bar{A}\bar{A}+\bar{A}\bar{D}\cdot(\bar{A}+BC)$

$F = \bar{A}\bar{A}\bar{D}+\bar{A}\bar{D}BC$

$F = \bar{A}\bar{D}+\bar{A}BC\bar{D}$

$F = \bar{A}\bar{D}(1+BC)$

$F = \bar{A}\bar{D}$

AB \ CD	00	01	11	10
00	1 (0)	1	3	1 (2)
01	1 (4)	5	7	1 (6)
11	12	13	15	14
10	8	9	11	10

→ $A\bar{D}$

$G = (\bar{A}+BC)(\overline{\bar{A}D})$

$G = \bar{A}\bar{A}\bar{D}+\bar{A}\bar{D}BC$

$G = \bar{A}(A+\bar{D})+(A+\bar{D})BC$

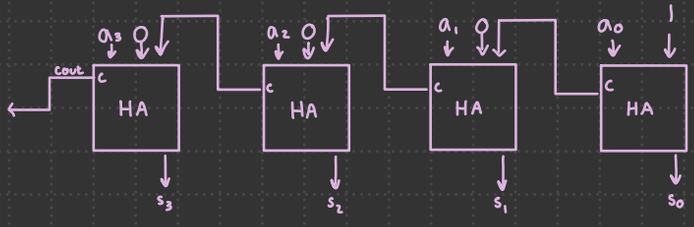
$G = 0+\bar{A}\bar{D}+ABC+BC\bar{D}$

$G = \bar{A}\bar{D}+ABC$

AB \ CD	00	01	11	10
00	1 (0)	1	3	1 (2)
01	1 (4)	5	7	1 (6)
11	12	13	1 (15)	14
10	8	9	11	10

→ $A\bar{D}$, → ABC

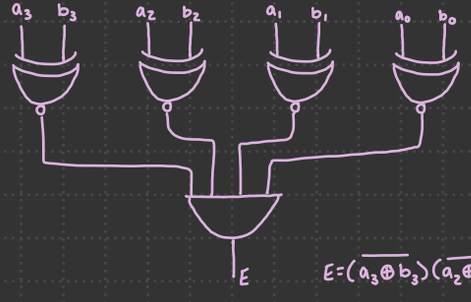
#6



#7

A	B	≠ XOR	= XNOR
0	0	0	1
0	1	1	0
1	0	1	0
1	1	0	1

$a_3a_2a_1a_0 \Rightarrow a_3 = b_3$ && $a_2 = b_2$ && ... etc.



$E = (\overline{a_3 \oplus b_3})(\overline{a_2 \oplus b_2})(\overline{a_1 \oplus b_1})(\overline{a_0 \oplus b_0})$

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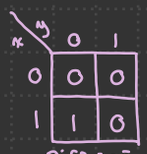
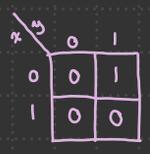
a)

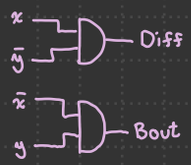
x	y	diff	bout
0	0	0	0
0	1	0	1
1	0	1	0
1	1	0	0



Diff = $x\bar{y}$

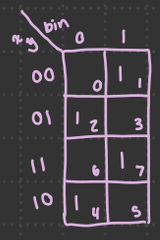


Bout = $\bar{x}y$



b)

	x	y	Bin	Diff	Bout
0	0	0	0	0	0
1	0	0	1	1	1
2	0	1	0	1	1
3	0	1	1	0	1
4	1	0	0	1	0
5	1	0	1	0	0
6	1	1	0	0	0
7	1	1	1	1	1

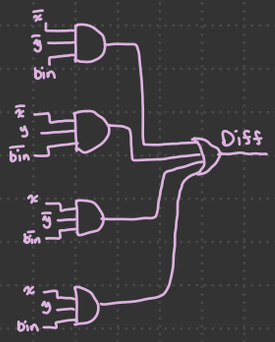


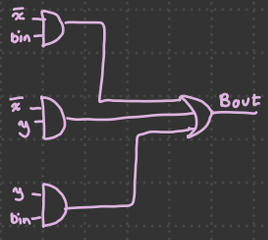
Diff

Diff = $\bar{x}\bar{y}bin + \bar{x}y\bar{bin} + x\bar{y}\bar{bin} + xybin$

Bout

Bout = $\bar{x}bin + \bar{x}y + ybin$





9

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

A

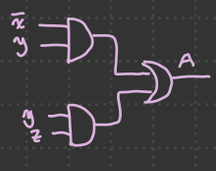
A = $\bar{x}y + yz$

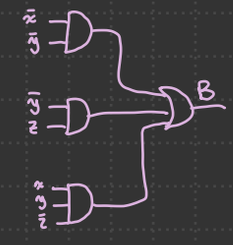
B

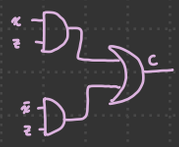
B = $\bar{x}\bar{y} + \bar{y}z + x\bar{y}\bar{z}$

C

C = $x\bar{z} + \bar{x}z$









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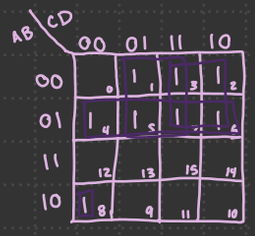
#10

(input)(output)

	A	B	C	D	w	x	y	z
0	0	0	0	0	0	0	0	0
1	0	0	0	1	1	1	1	1
2	0	0	1	0	1	1	1	0
3	0	0	1	1	1	1	0	1
4	0	1	0	0	1	1	0	0
5	0	1	0	1	1	0	1	1
6	0	1	1	0	1	0	1	0
7	0	1	1	1	1	0	0	1
8	1	0	0	0	1	0	0	0
9	1	0	0	1	0	1	1	1
10	1	0	1	0	0	1	1	0
11	1	0	1	1	0	1	0	1
12	1	1	0	0	0	1	0	0
13	1	1	0	1	0	0	1	1
14	1	1	1	0	0	0	1	0
15	1	1	1	1	0	0	0	1

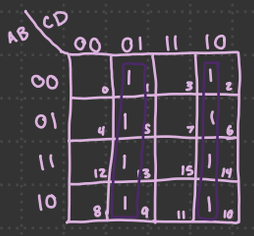


w

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

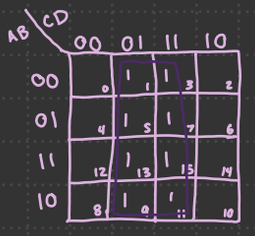
x

$x = \bar{B}D + \bar{B}C + B\bar{C}\bar{D}$



y

$y = \bar{C}D + C\bar{D}$



z

$z = D$