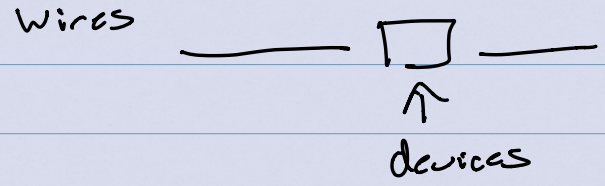
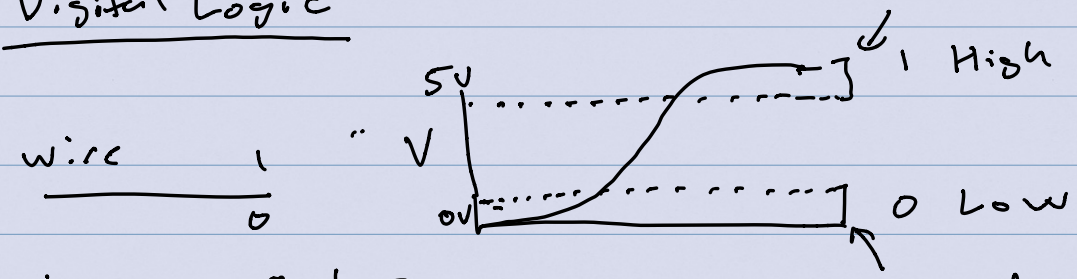
Digital Design

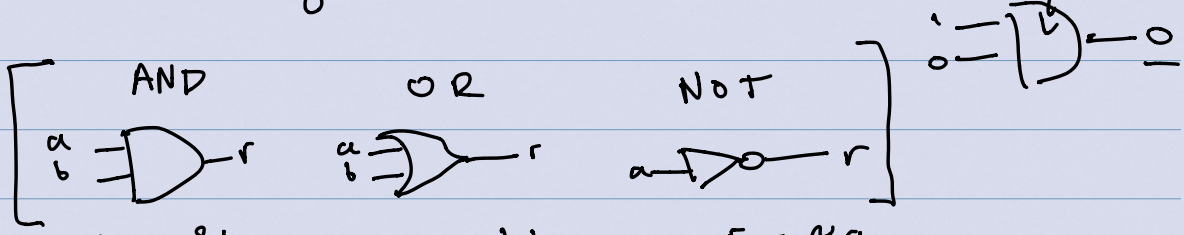
Digital Circuits – electrical



Digital Logic



Devices ⇒ gates



	AND	OR	NOT
C code	$r = a \,\&\, b$	$r = a \mid b$	$r = \sim a$
Boolean Algebra	$r = a \cdot b$	$r = a + b$	$r = \bar{a}$
Logic	$r = a \wedge b$	$r = a \vee b$	$r = \neg a$

$a \cdot b$

a	b	r
0	0	0
0	1	0
1	0	0
1	1	1

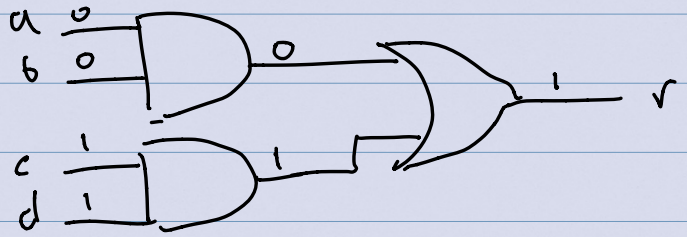
$a + b$

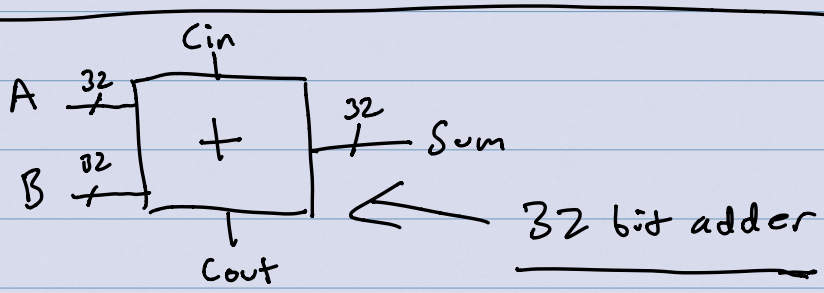
a	b	r
0	0	0
0	1	1
1	0	1
1	1	1

$\bar{a}$

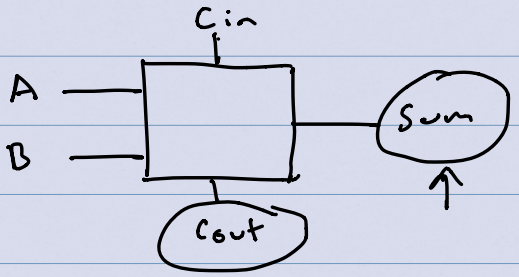
a	r
0	1
1	0

Abstraction





32 bit adder



1 bit full adder

1 bit halfaddre

inputs

A B Cin

outputs

sum cout

↑

sum of products

sum plus ← XOR

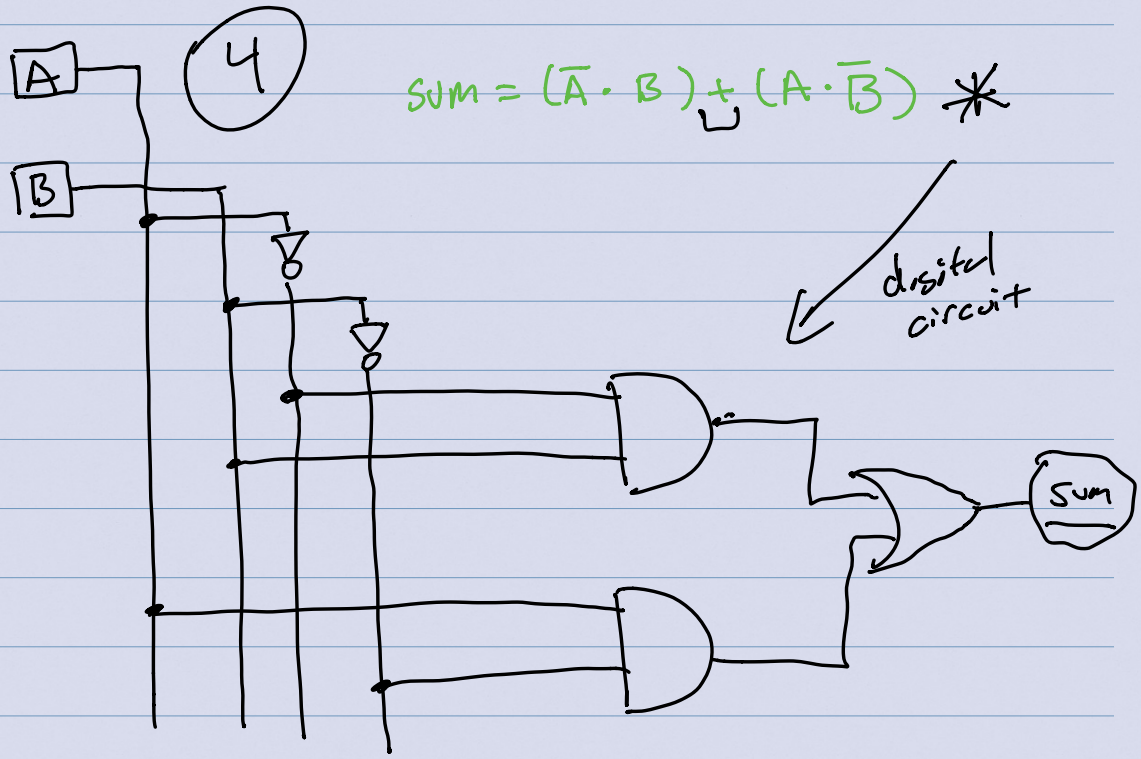
A + B

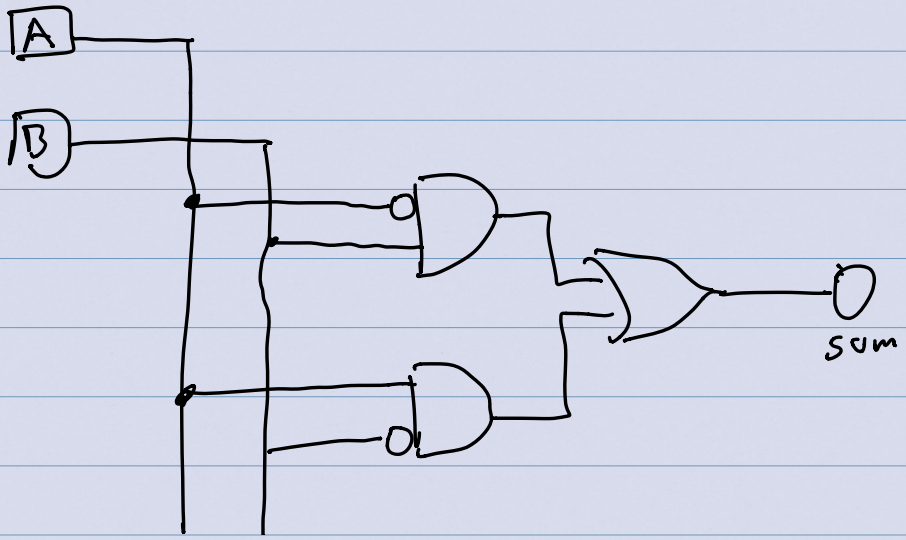
① ② ③

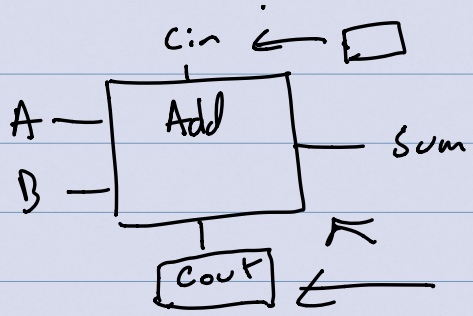
A	B	A + B
0	0	0
→ 0	1	1
→ 1	0	1
1	1	0

$SUM = (\bar{A} \cdot B) + (A \cdot \bar{B})$

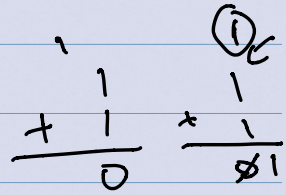
A	B	$\bar{A} \cdot B$	$A \cdot \bar{B}$	$(\bar{A} \cdot B) + (A \cdot \bar{B})$
0	0	0	0	0
0	1	1	0	1
1	0	0	1	1
1	1	0	0	0

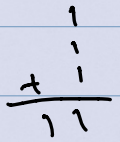






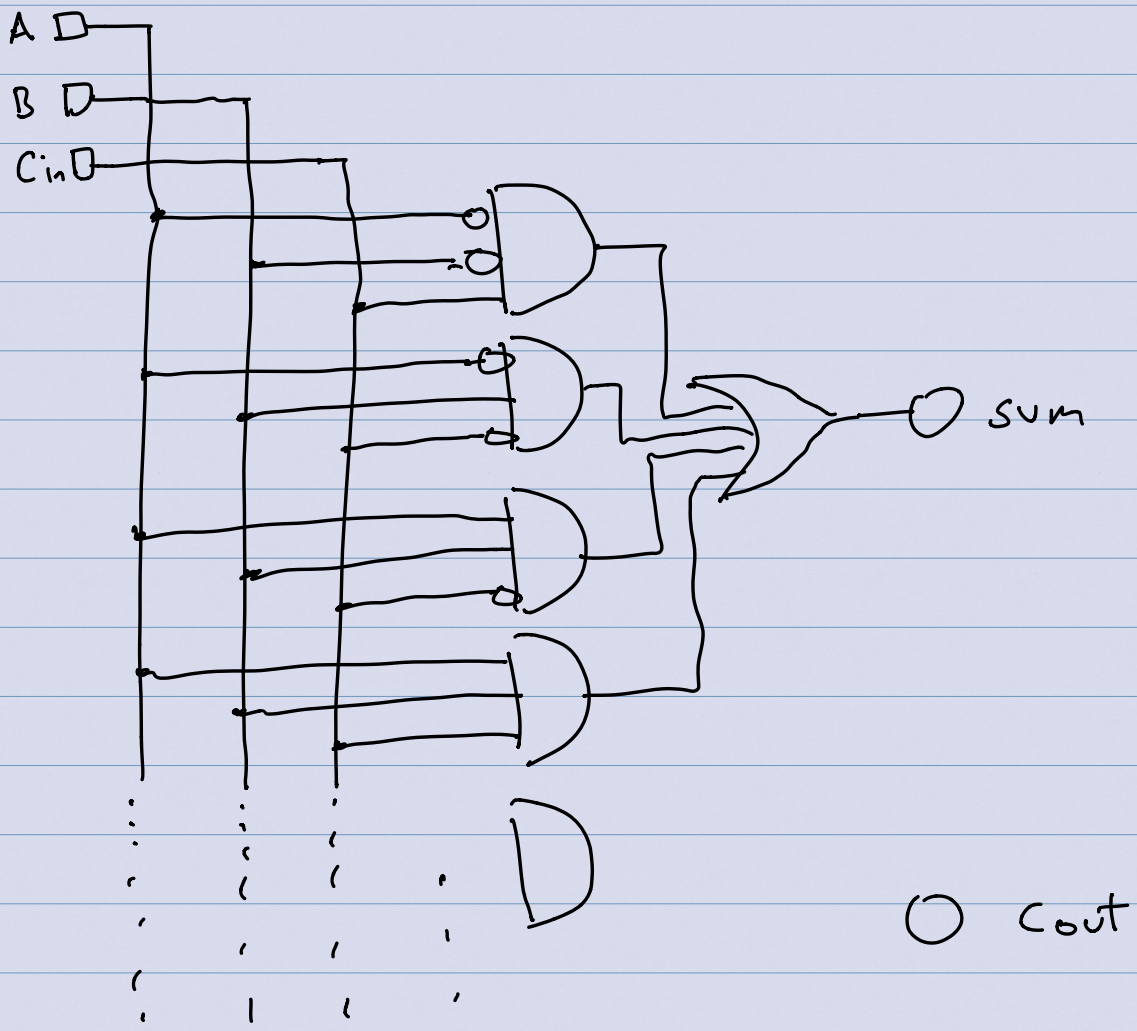
$2^3 = 8$



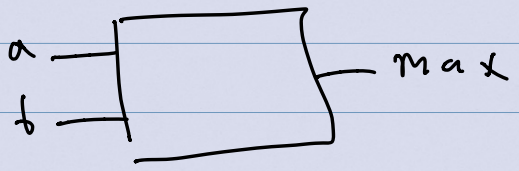


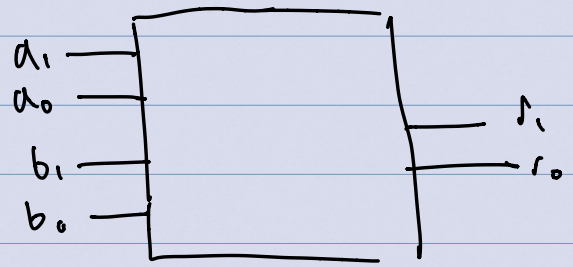
A	B	Cin	Sum	Cout
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

$$Sum = (\bar{A} \cdot \bar{B} \cdot C_{in}) + (\bar{A} \cdot B \cdot \bar{C_{in}}) + (A \cdot \bar{B} \cdot \bar{C_{in}}) + (A \cdot B \cdot C_{in})$$



Part 3





$2^4 = 16$

a_1	a_0	b_1	b_0	r_1	r_0
0	0	0	0	0	0
0	0	0	1	0	1
0	0	1	0	1	0
0	0	1	1	1	1
⋮					
1					