ESD - Elettronica dei Sistemi Digitali

Exercises on Boolean Algebra

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1 Boolean Algebra Exercises

1.1 Exercise 1

For each given truth table, write the Boolean equation in canonical **sum-of-products** form. Then simplify the expression to its minimal form using the theorems of Boolean algebra. Finally, implement the corresponding combinational circuit and verify its correctness by simulating it in DEEDS

1.1.1 (a)

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

1.1.2 (b)

A	B	C	Y
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	1
1	1	1	0

1.1.3 (c)

A	B	C	Y
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

1.1.4 (d)

A	B	C	D	Y
0	0	0	0	0
0	0	0	1	1
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	1
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	0
1	1	0	0	0
1	1	0	1	0
1	1	1	0	1
1	1	1	1	1

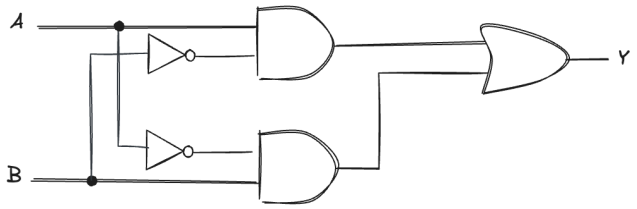
1.1.5 (e)

A	B	C	D	Y
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	1
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	1
1	0	0	0	1
1	0	0	1	1
1	0	1	0	1
1	0	1	1	0
1	1	0	0	0
1	1	0	1	0
1	1	1	0	0
1	1	1	1	0

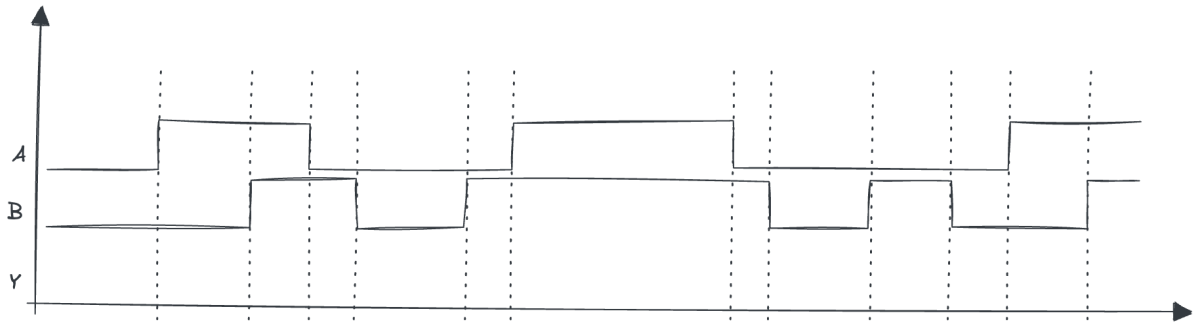
1.2 Exercise 2

Complete the truth table and the timing diagram of the following digital circuits. Then derive the Boolean equation in canonical **sum-of-products** form and simplify it to its minimal expression using Boolean algebra theorems. Finally, implement the corresponding circuit in DEEDS and verify the correctness of your solution.

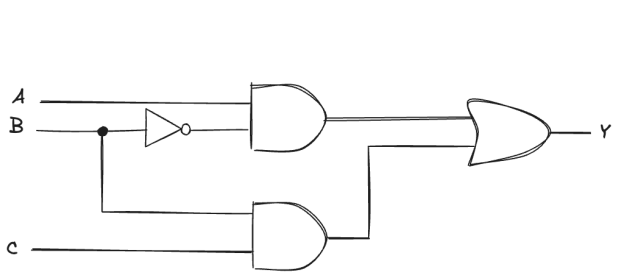
1.2.1 (a)



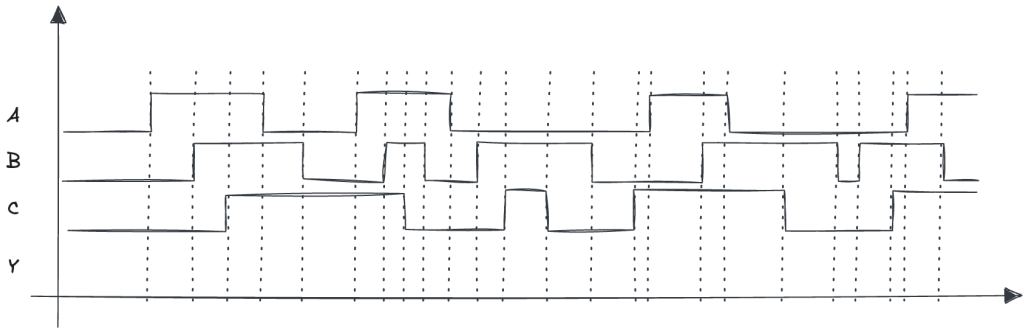
A	B	Y
0	0	
0	1	
1	0	
1	1	



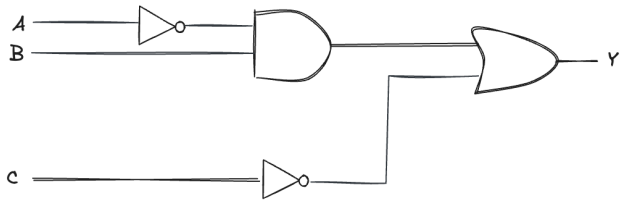
1.2.2 (b)



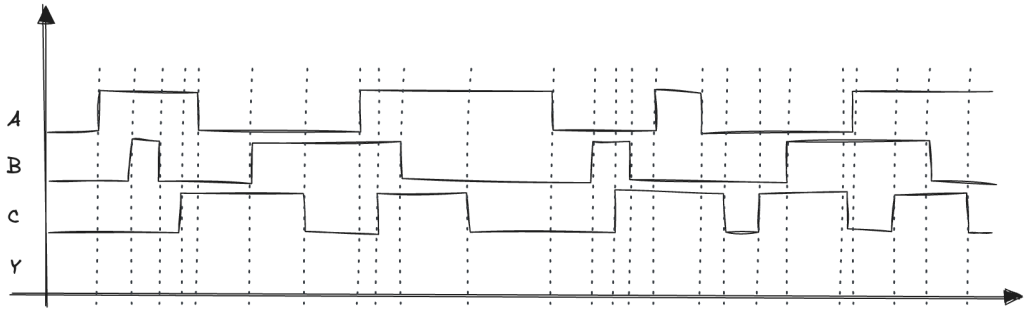
A	B	C	Y
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	



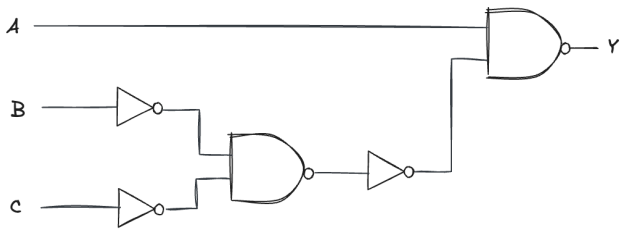
1.2.3 (c)



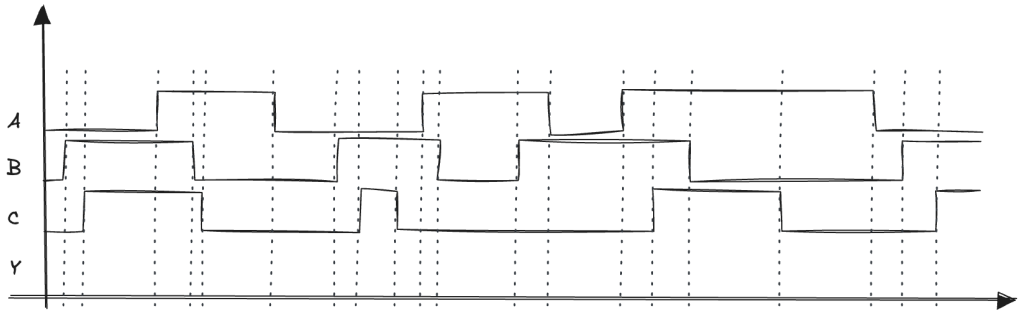
A	B	C	Y
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	



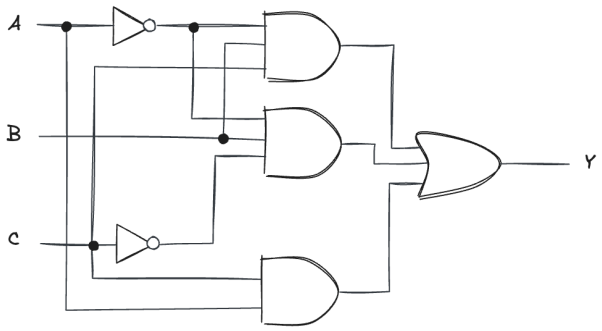
1.2.4 (d)



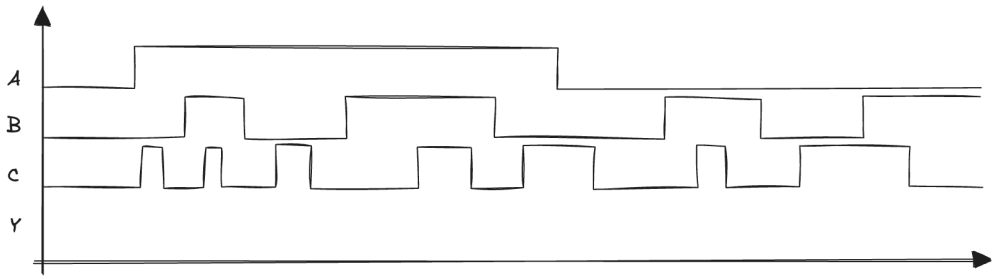
A	B	C	Y
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	



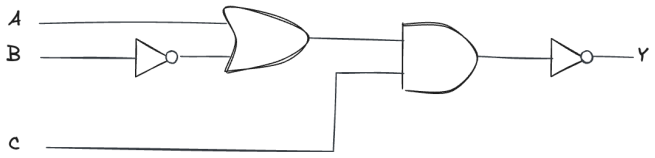
1.2.5 (e)



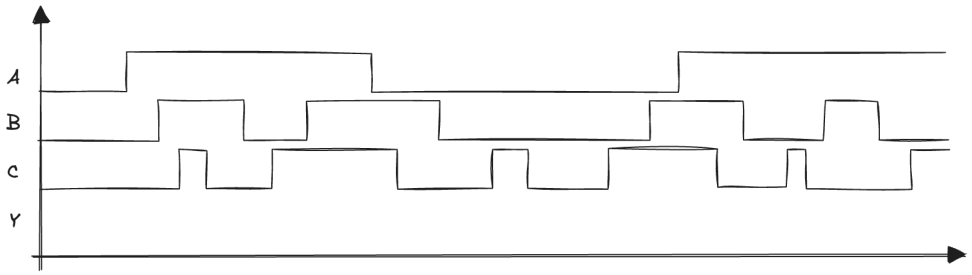
A	B	C	Y
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	



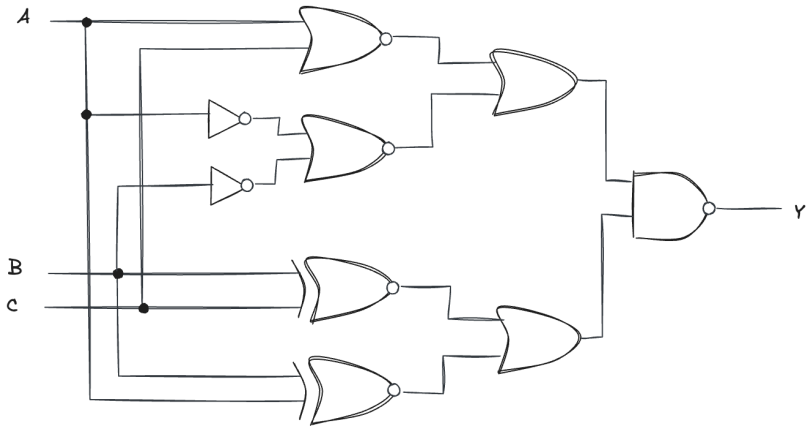
1.2.6 (f)



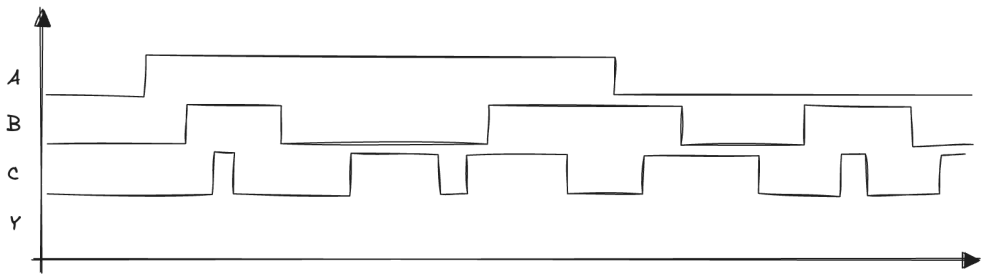
A	B	C	Y
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	



1.2.7 (g)



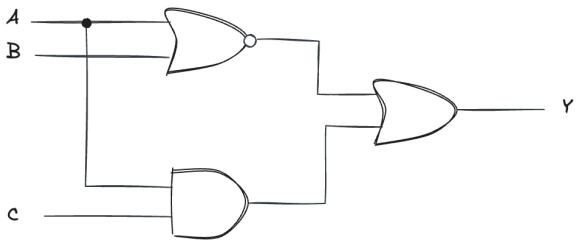
A	B	C	Y
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	



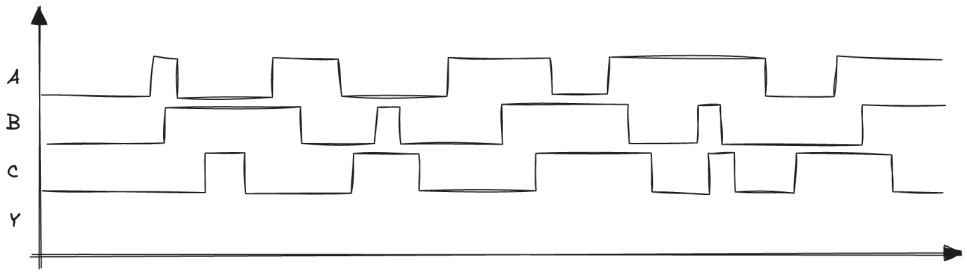
1.3 Exercise 3

Complete the truth table and the timing diagram of the following digital circuits. Then derive the Boolean equation in canonical **product-of-sums** form and simplify it to its minimal expression using Boolean algebra theorems. Finally, implement the corresponding circuit in DEEDS and verify the correctness of your solution.

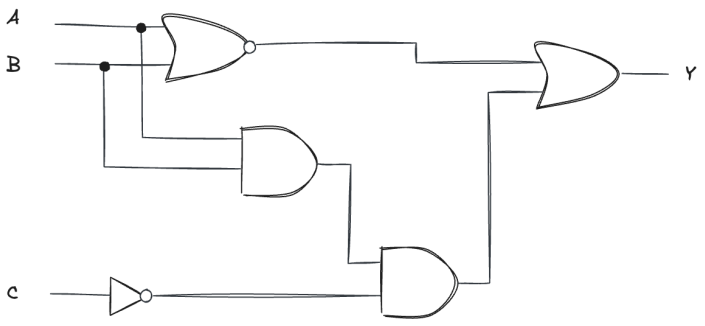
1.3.1 (a)



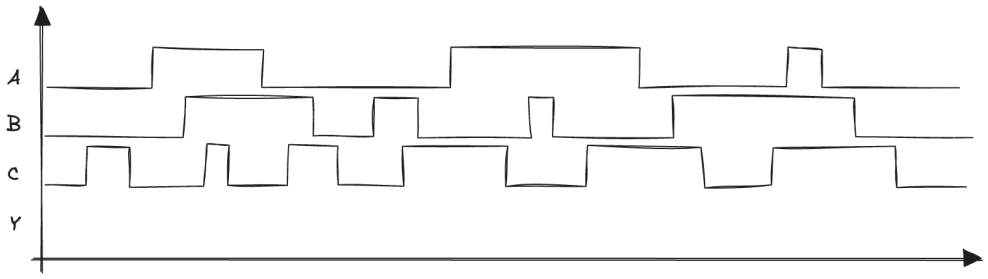
A	B	C	Y
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	



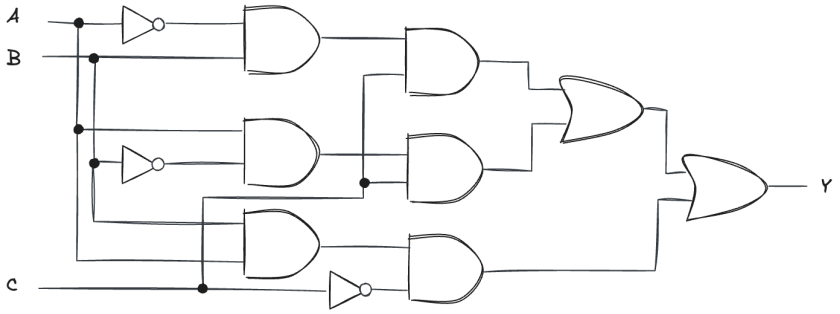
1.3.2 (b)



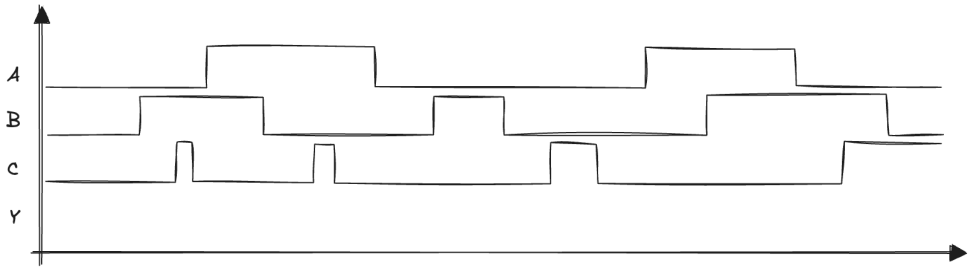
A	B	C	Y
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	



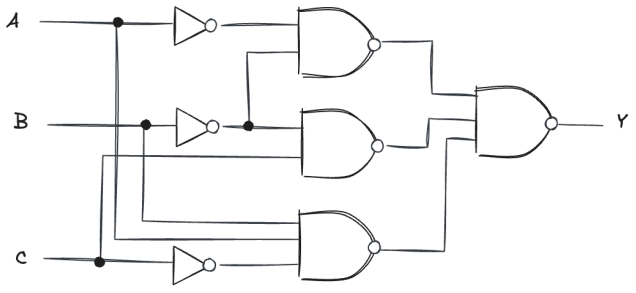
1.3.3 (c)



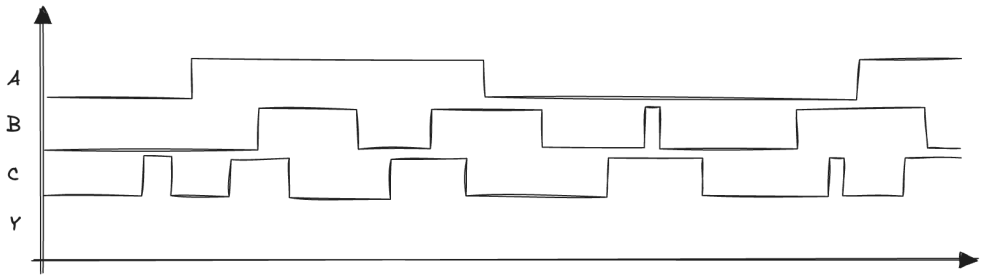
A	B	C	Y
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	



1.3.4 (d)



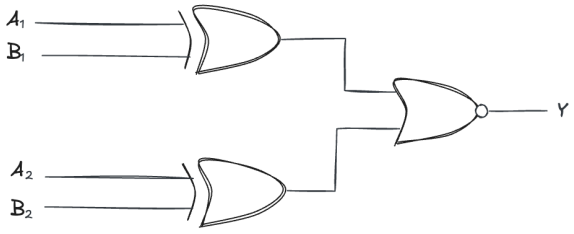
A	B	C	Y
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	



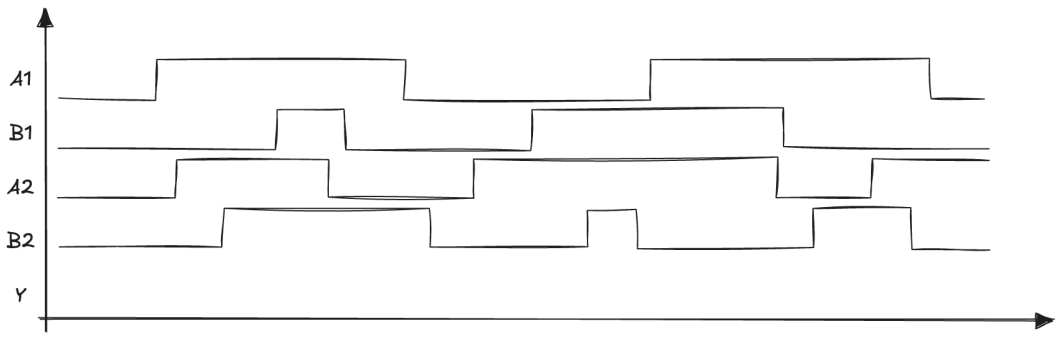
1.4 Exercise 4

Consider the following circuits. The first one is a **2-bit comparator**, which determines whether the value of A is equal to the value of B. The second one is a **1-bit adder**, which adds A, B, and the input carry, generating both the sum and the carry outputs. Complete the truth table and the timing diagram. Explain the operation of the two circuits in light of the truth table, and verify that they behave as expected. Then implement the corresponding circuits in DEEDS and verify the correctness of your solutions through simulation.

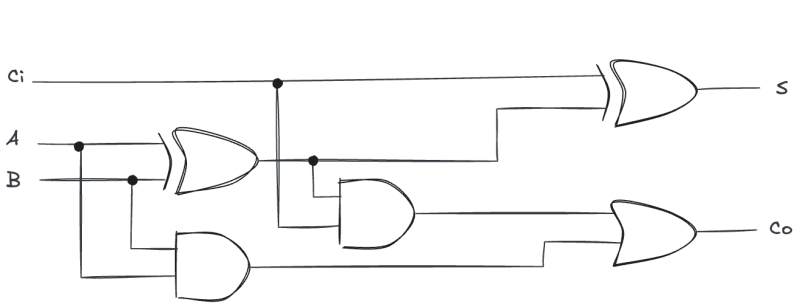
1.4.1 (a) 2-bit comparator



A1	B1	A2	B2	Y
0	0	0	0	
0	0	0	1	
0	0	1	0	
0	0	1	1	
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	



1.4.2 (b) 1-bit adder



A	B	Ci	S	Co
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1