December 4, 2020

Istanbul Technical University

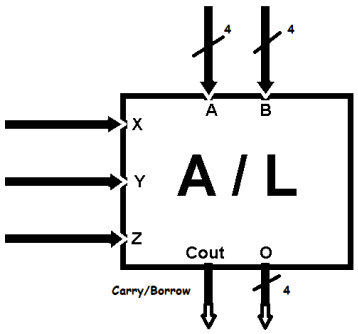
Department of Computer Engineering

BLG 231E - Digital Circuits

Solutions for Assignment 4

1. The combinational circuit ARITHMETIC/LOGIC **(A/L)** performs the following operations depending on the value of the control inputs X, Y, and Z.

X	Y	Z	Result (O)	Cout
0	0	0	B – A	Borrow
0	0	1	A + B	Carry
0	1	0	A – 5	Borrow
0	1	1	Φ	Φ
1	0	0	A · B	Φ
1	0	1	Φ	Φ
1	1	0	A ⊕ B	Φ
1	1	1	Φ	Φ



The meanings of symbols are given below:

Symbol	Meaning
+	Arithmetic addition
-	Arithmetic subtraction
·	4-bit logic AND between corresponding bits of A and B: $A_3 \cdot B_3$, …, $A_0 \cdot B_0$.
⊕	4-bit logic XOR between corresponding bits of A and B: $A_3 \oplus B_3$, …, $A_0 \oplus B_0$.
Φ	Don't care

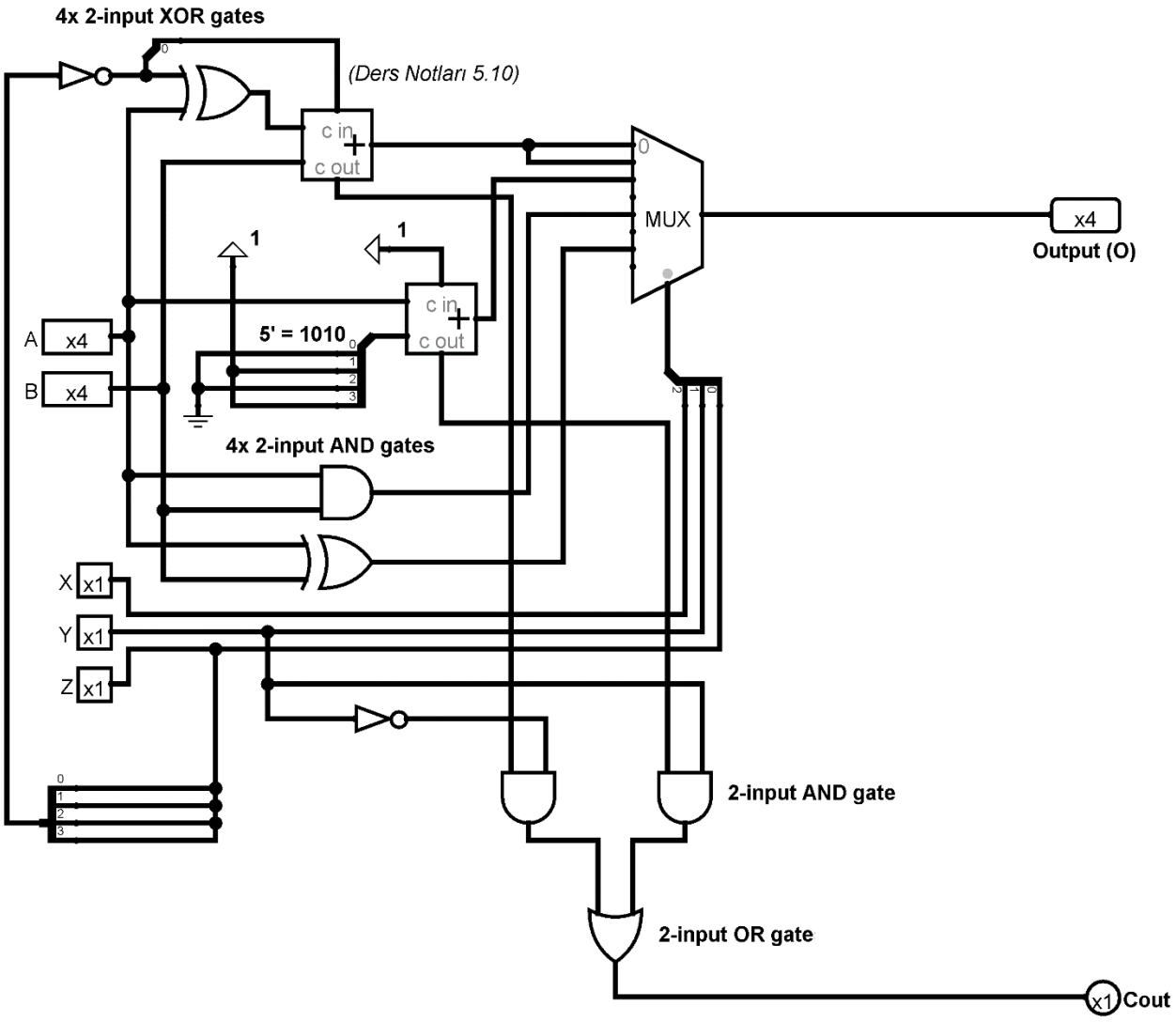
Design and draw this circuit using **only** the standard components and logic gates given below, paying attention to the maximum number allowed for the first three:

Type	Maximum number allowed
4-bit parallel adders	2
8:1 multiplexer	1
2:4 decoder	1
XOR gates	No restriction
NOT gates	No restriction
OR gates	No restriction
AND gates	No restriction

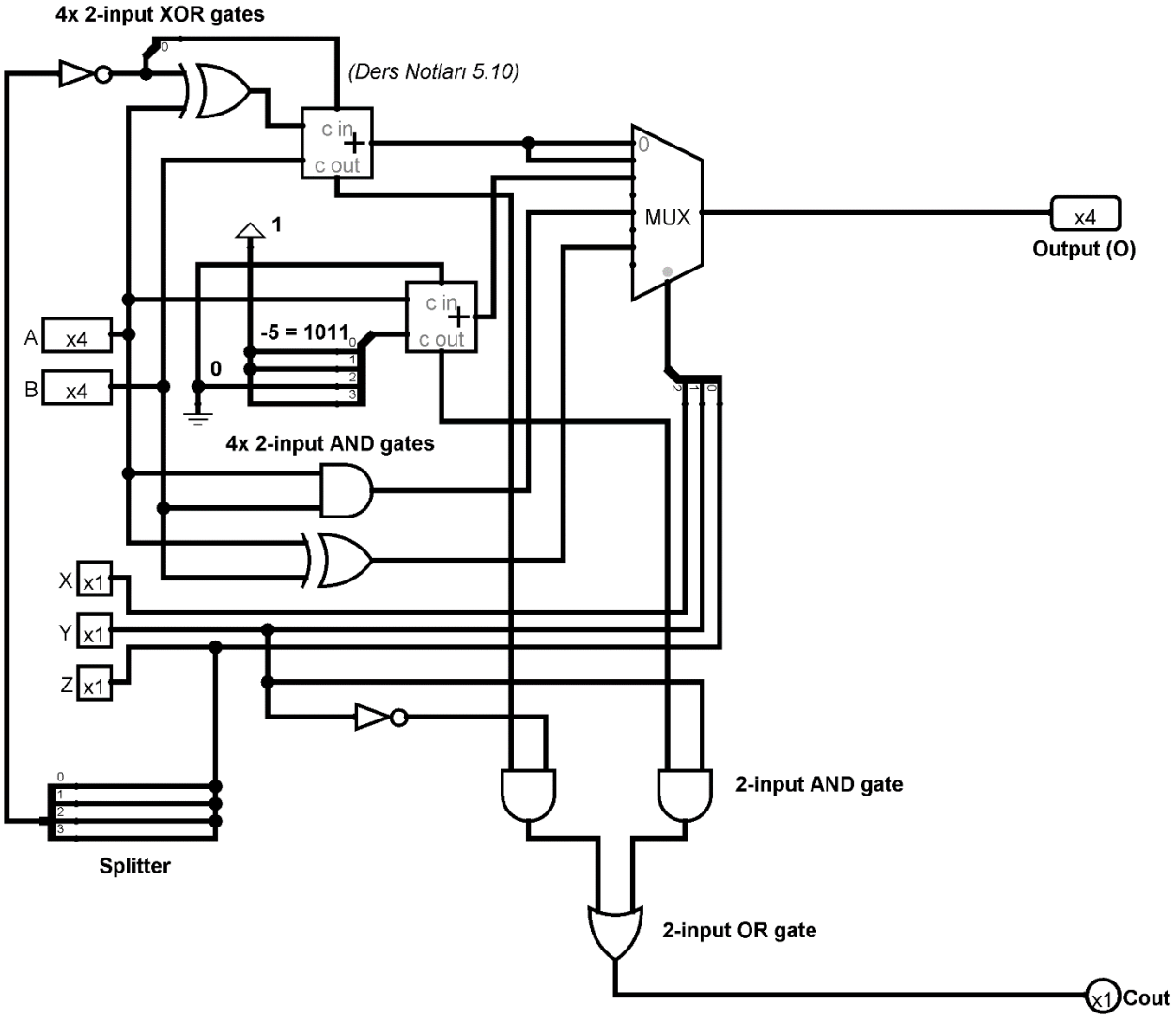
Note: Even though we have not specified a maximum number allowed on the last four, you should try to use as few as possible (also, you do not need to use all of the gates listed above). Your design should be as simple as possible, containing the fewest number of standard components and logic gates.

- Solution:

Design 1:



Design 2:


4x 2-input XOR gates
(Ders Notları 5.10)
c in
c out
0
MUX
x4
Output (O)
1
A
x4
B
x4
-5 = 1011
0
4x 2-input AND gates
X
x1
Y
x1
Z
x1
2-input AND gate
Splitter
2-input OR gate
x1
Cout