Ch19

Logic Circuits and Boolean Algebra

CHAPTER ASSIGNMENT · 49 MARKS

Name _____ Class _____ No. _____ Date _____

Answer every question in the space given. Show your working. You may use the chapter page to help you.

Questions from *Computer Science for Cambridge International AS & A Level Coursebook*, 2nd edition, Sylvia Langfield and Dave Duddell (Cambridge University Press), for classroom use.

Tasks and questions from the chapter

Q19.01 In Figure 19.02, can you identify the individual circuits that represent the AND operator and the XOR operator?

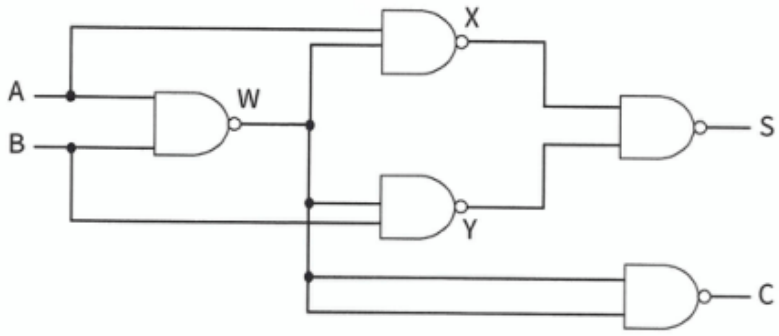


Figure 19.02 A half adder circuit constructed from NAND gates

19.01 Use the intermediate points labelled W, X and Y to construct a truth table for the circuit shown in Figure 19.02. Check that this reproduces the truth table shown as Table 19.01.

A	B	W	X	Y	S	C
0	0					
0	1					
1	0					
1	1					

DP **Discussion Point:** Can you see how full adders could be combined to handle addition of, for example, four-bit binary numbers? What happens to the carry input for the first addition?

19.02 Find a diagram for a NAND gate SR flip-flop and construct the truth table.

Q19.02 Can you follow the logic in the JK flip-flop circuit to see that the truth table is an accurate representation of the logic for all combinations of input?

19.03 It is vital that you can interpret a Boolean expression correctly. Go through Table 19.05 item by item and in each case read out the full meaning. For example:

`1 + A = 1` can be read as 'one plus A equals 1'

but must be understood as 'TRUE OR A is TRUE'.

EQ19.01 **Extension Question 19.01:** Worked Example 19.02 did not show that the circuit produced the correct output for C. Also a shortcut was used to reach the final form of S. Can you use Boolean algebra to find the form of C from the circuit and can you convert the expression for S if you start by using the distributive law before applying De Morgan's law?

EQ19.02 **Extension Question 19.02:** Consider the Karnaugh map shown in Figure 19.10. This corresponds to a problem with four inputs. It wraps round horizontally and vertically. Use the map to create a Boolean algebra expression.

AB \ CD	00	01	11	10
00	1	0	1	1
01	0	0	1	1
11	0	0	1	1
10	1	0	0	0

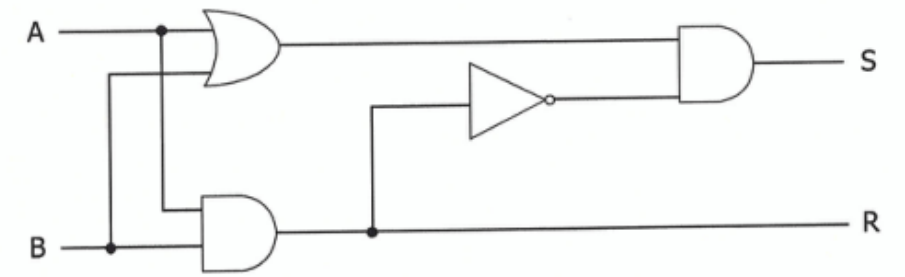
Figure 19.10 A K-map for a four input problem

RP **Reflection Point:** When using Karnaugh maps will you remember to use Gray coding if there are three inputs and will you remember to use all overlapping groups?

Exam-style questions

1

(a) Consider the following circuit:



(i) Identify the **three** different logic gates used. [2]

(ii) Complete the following truth table for the circuit for the inputs shown for A and B. [5]

A	B	Workspace	S	R
0	0			
0	1			
1	0			
1	1			

(b) For the circuit shown in **part a**, identify the type of circuit and what the outputs represent. [3]

2

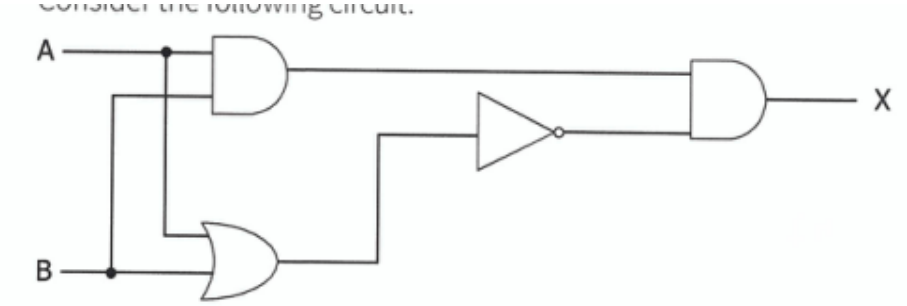
(a) Consider the following truth table:

A	B	X
0	0	1
0	1	0
1	0	1
1	1	1

(i) Using the sum-of-products approach, write a Boolean expression that matches the logic. [3]

(ii) For the rows that have A = 1, the output for X is 1. Explain how this would be reflected in a simplified form of Boolean expression matching the truth table. [2]

(b) Consider the following circuit:



(i) Using your knowledge of the truth table for an AND gate, write a Boolean algebra expression for the output from the first AND gate. [2]

(ii) Using your knowledge of the truth table for an OR gate write a Boolean algebra expression for the output from the OR gate. [3]

(iii) Using De Morgan's law, write the logic expression for the output from the NOT gate. [4]

3

(a) Consider the following truth table:

A	B	X
0	0	1
0	1	0
1	0	1
1	1	1

(i) Sketch a Karnaugh map to match this truth table. [4]

(ii) Use the Karnaugh map to write a Boolean algebra expression for this logic. [3]

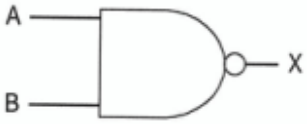
(b) Consider the truth table shown in **part a**.

(i) Use the sum-of-products method to write a Boolean algebra expression from the truth table. [3]

(ii) Use Boolean algebra to demonstrate that this expression can be simplified to give the same expression created from the Karnaugh map. Hint: you might wish to use the fact that $A.\bar{B} = A.\bar{B} + A.\bar{B}$. [3]

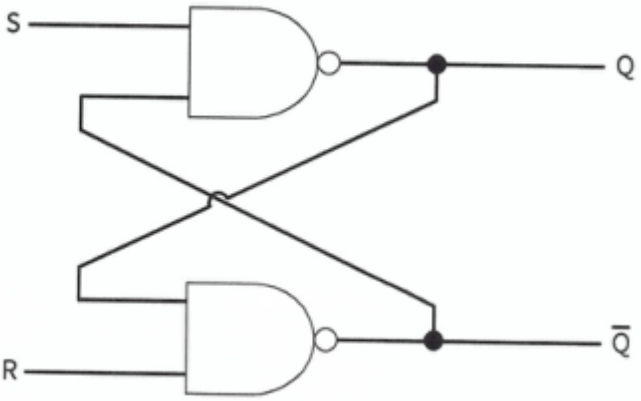
4

(a) Complete the truth table for this NAND gate: [1]



A	B	X
0	0	
0	1	
1	0	
1	1	

An SR flip-flop is constructed using two NAND gates.



(b) Complete the truth table for the SR flip-flop. [4]

(i)

State	S	R	Q	$\bar{Q}$
Initially	1	0	0	1
R change to 1	1	1		
S changed to 0	0	1		
S changed to 1	1	1		
S and R changed to 0	0	0		

(ii) One of the combinations in the truth table should not be allowed to occur.
State the values of S and R that should not be allowed. Justify your choice. [3]

Another type of flip-flop is the JK flip-flop.

(c) Give **one** extra input present in the JK flip-flop. [1]

(i)

(ii) Give **one** advantage of the JK flip-flop. [1]

(d) Describe the role of flip-flops in a computer. [2]

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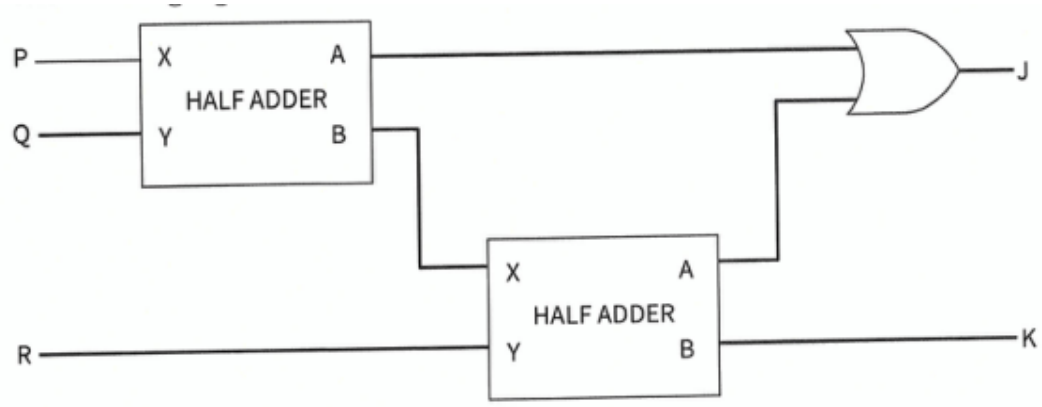
5

(a) A half adder is a logic circuit with the following truth table.

(i)

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

The following logic circuit is constructed.



Complete the following truth table for this logic circuit. [2]

Input			Working space	Output	
P	Q	R		J	K
0	0	0			
0	0	1			
0	1	0			
0	1	1			
1	0	0			
1	0	1			
1	1	0			
1	1	1			

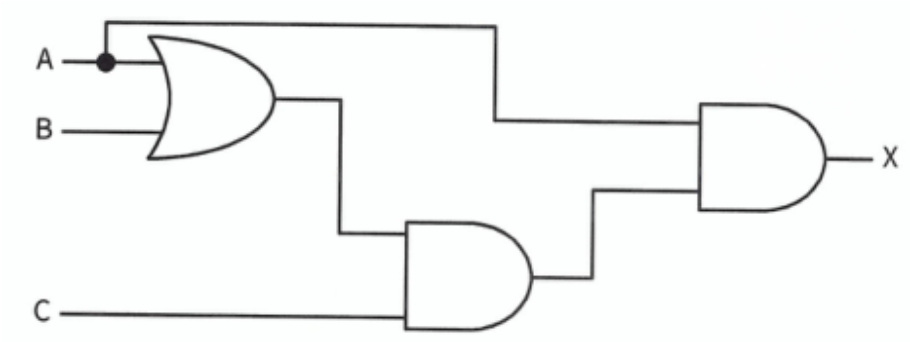
(ii) State the name given to this logic circuit. [1]

(iii) Name the labels usually given to **J** and **K**.

Explain why your answers are appropriate labels for these outputs. [4]

(b) Write down the Boolean expression corresponding to the following logic circuit: [2]

(i)



(ii) Use Boolean algebra to simplify the expression given in **part b(i)**.

Show your working. [4]

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End of assignment · Check your answers against the chapter at gurujazzy.com/subjects/computer-science/as-a-level/logic-circuits-boolean-algebra/