Ch4

Logic Gates and Logic Circuits

CHAPTER ASSIGNMENT · 63 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

4.01 Convert the conditions in the following problem statement into a simple logic expression:

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4.02 Without looking further on in the chapter, construct the truth table for the OR operator.

4.03 Draw a circuit where A and B are input to an AND gate, from which the output is carried to a NOT gate, from which there is an output X. Show that this has the same outcome as having one NAND gate.

EQ4.01 **Extension Question 4.01:** Could the same outcome be produced by positioning a NOT gate before the AND gate?

Q4.01 Can you recall from memory the symbols and definitions of the six logic gates introduced in this chapter?

4.04 An oven has a number of components that should all be working properly. For each component there is a signalling mechanism that informs a management system either if all is well, or if there is a problem. Table 4.05 summarises the signal values that record the status for each component.

Signal	Value	Component condition
A	0	Fan not working
	1	Fan working properly
B	0	Internal light not working
	1	Internal light working properly
C	0	Thermometer reading too high
	1	Thermometer reading in range

Table 4.05 Signals from the oven components

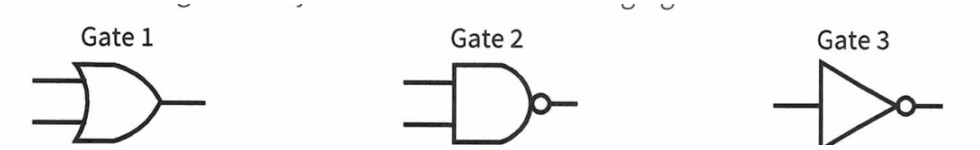
If the thermometer reading is in range but either or both the fan and light are not working, the management system has to output a signal to activate a warning light on the control panel. Draw a logic circuit for this fault condition.

RP **Reflection Point:** Looking back over the chapter content, what would you say is the central concept in the subject matter?

Exam-style questions

1

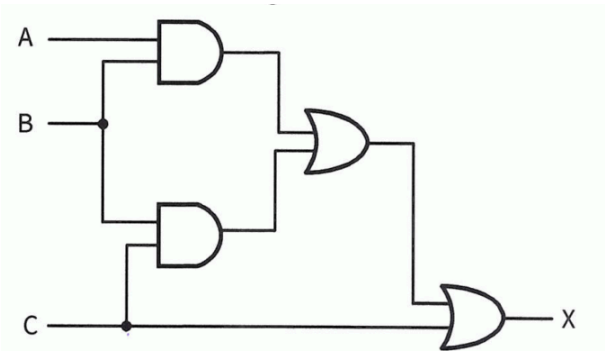
(a) The following are the symbols for three different logic gates.



(i) Identify each of the logic gates. [3]

(ii) Sketch the truth table for either Gate 1 or Gate 2. [2]

(b) Consider the following circuit:



(i) Complete the truth table for the circuit using the following template: [8]

Inputs			Workspace			Output
A	B	C				X
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) There is an element of redundancy in this diagram. Explain what the problem is. [2]

2

(a) The definition of the NAND gate can be expressed as: [2]

A NAND B is TRUE if A is FALSE or B is FALSE

Sketch the truth table for a NAND gate.

(b) Consider the following statement:

In a competition, two teams play two matches against each other. One of the teams is declared the winner if one of the following results occurs:

- The team wins both matches.
- The team wins one match and loses the other but has the highest total score.

(i) Identify the **three** logic propositions in this statement. [3]

(ii) By assigning the symbols A, B and C to these three propositions give the outcome of the competition as a logic expression. [3]

(iii) Sketch a logic circuit to match this logic expression. [4]

3 A domestic heating system has a hot water tank and a number of radiators. There is a computerised management system which receives signals. These signals indicate whether or not the conditions for components are as they should be. The following table summarises the signals received:

Signal	Value	Component condition
A	0	Water flow in the radiators is too low
	1	Water flow in the radiators is within limits
B	0	Hot water tank temperature too high
	1	Hot water tank temperature within limits
C	0	Water level in hot water tank too low
	1	Water level in hot water tank within limits

(a) Consider the following fault condition. The water level in the hot water tank is too low and the temperature in the hot water tank is too high. The management system must output a signal to switch off the system.

(i) Sketch a truth table for this fault condition including the A, B and C signals. [4]

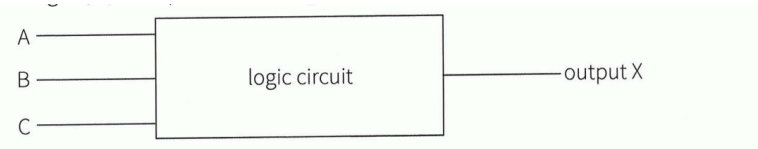
(ii) Sketch the circuit diagram for this fault condition to match this truth table. [5]

(b) Consider the fault condition where the hot water tank temperature is within limits but the water flow in the radiators is too low and the water level in the hot water tank is too low. Sketch the circuit diagram for this fault condition which requires the management system to output a signal to increase water pressure. [5]

4

(a) Three digital sensors A, B and C are used to monitor a process. The outputs from the sensors are used as the inputs to a logic circuit. [5]

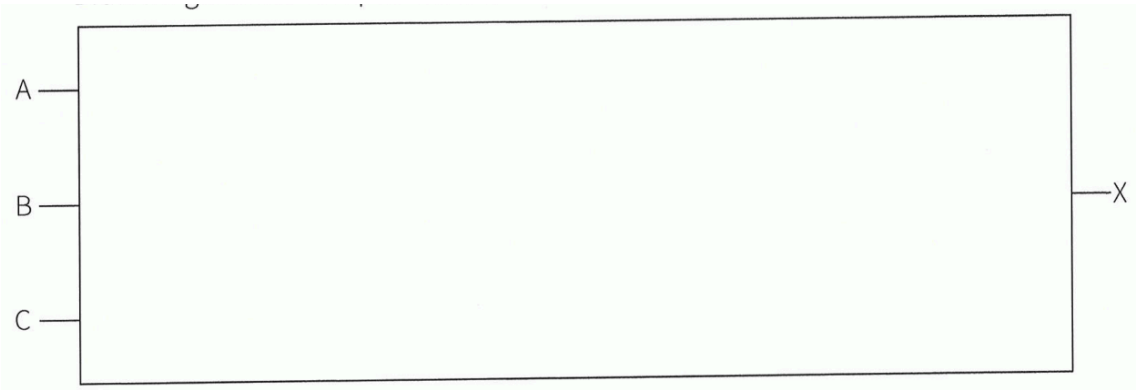
A signal, X, is output from the logic circuit:



Output, X, has a value of 1 if either of the following two conditions occur:

- sensor A outputs the value 1 OR sensor B outputs the value 0
- sensor B outputs the value 1 AND sensor C outputs the value 0

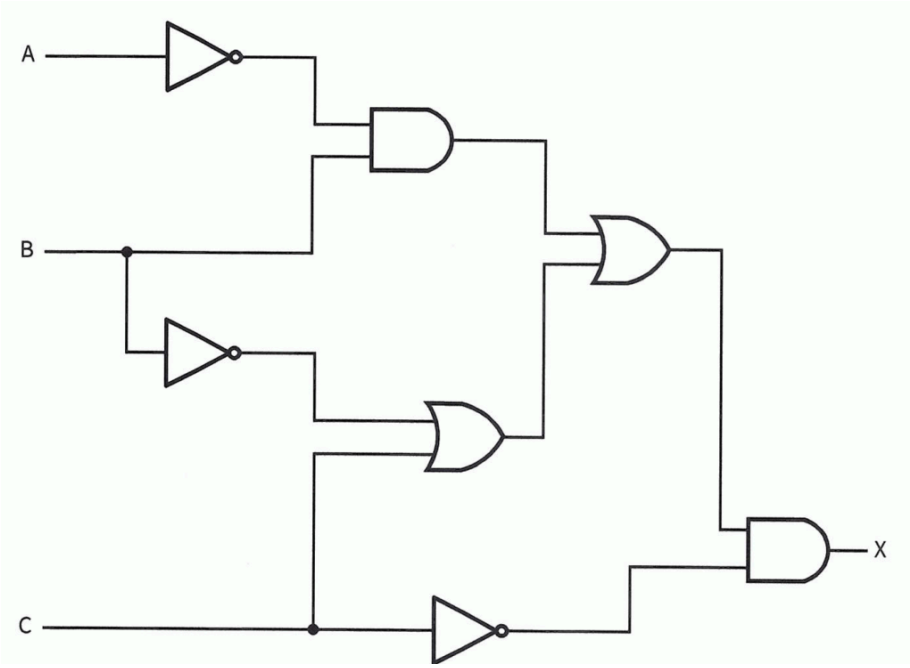
Draw a logic circuit to represent these conditions.



(b) Complete the truth table for the logic circuit described in **part (a)**. [4]

A	B	C	Workspace	X
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

(c) Write a logic statement that describes the following logic circuit. [3]



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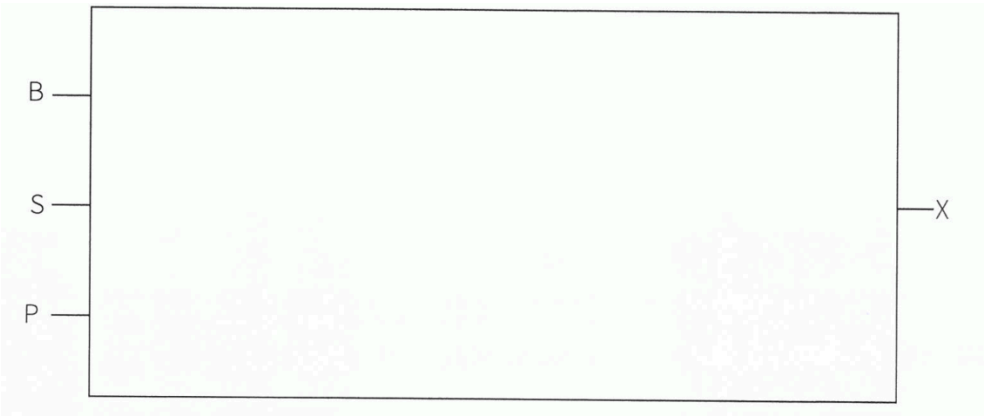
5

(a) A student writes the following logic expression: [6]

X is 1 IF (B is NOT 1 AND S is NOT 1) OR (P is NOT 1 AND S is 1)

Draw a logic circuit to represent this logic expression.

Do **not** attempt to simplify the logic expression.



(b) Complete the truth table for the logic expression given in **part (a)**. [4]

B	S	P	Workspace	X
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

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