T10

Boolean logic

CHAPTER ASSIGNMENT · 52 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 *Cambridge IGCSE and O Level Computer Science*, 2nd edition, David Watson and Helen Williams (Hodder Education), for classroom use.

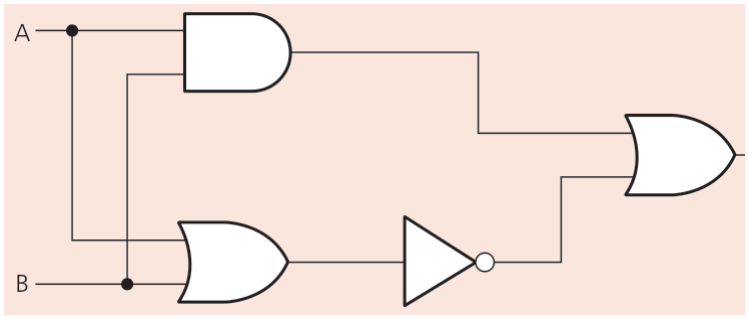
Activities from the chapter

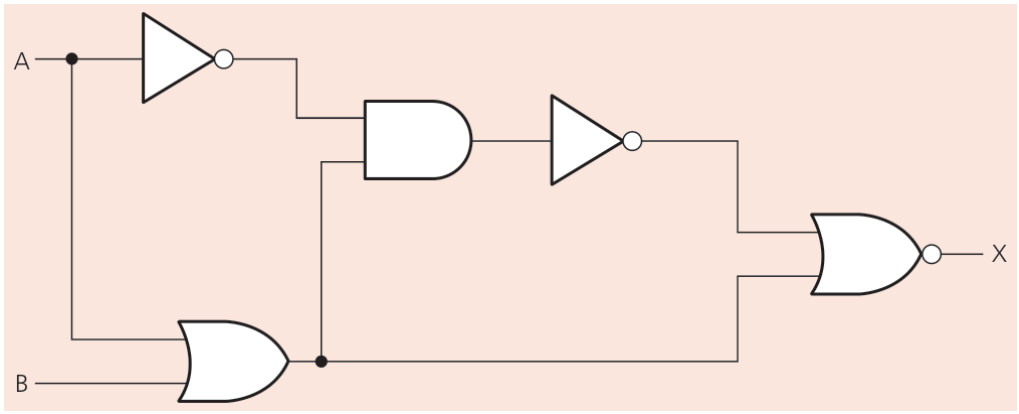
10.1 Show why X = (A AND NOT B) OR (NOT A AND B) and Y = (A OR B) AND (NOT (A AND B)) both represent the same logic gate.

10.2

(1) Produce truth tables from the following logic circuits:

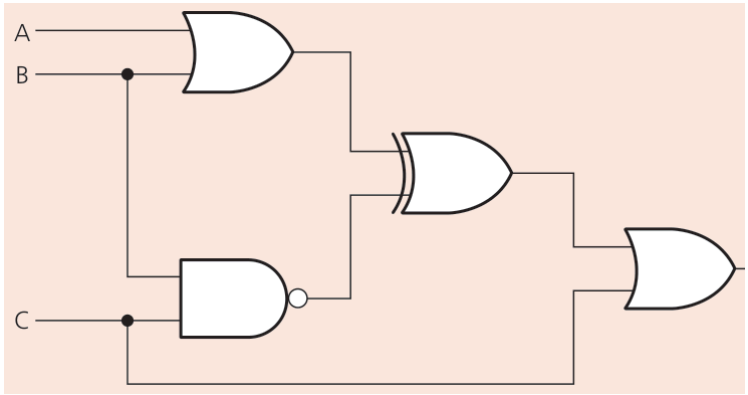
(a) X





(b) ▲ Figure 10.14 ▲ Figure 10.15

(c) X ▲ Figure 10.16



10.3

(NOT A AND B) AND (NOT B OR C)

(A XOR B) OR ((B NOR C) AND B)

Produce:

i a logic expression

ii a logic circuit

from the following truth table:

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

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

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

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

(NOT A AND NOT B) OR (A AND NOT B)

(1) Produce:

(i) a truth table

(ii) a logic circuit

(2) from the following logic expression: Produce:

(i) a truth table

(ii) a logic circuit

(3) from the following logic expression: Produce:

(4) Write down a logic expression for

(a)

(5) Write down a logic expression corresponding to the following truth table:

(a)

(b) Show that the following logic expression produces the same output as your answer to part **each** of the following truth tables:

(a) above:

(b)

10.4

(1) Draw the logic circuits and complete the truth tables for the following logic or Boolean expressions:

(a) X = (A OR B) OR (NOT A AND B)

(b) Y = (NOT A AND NOT B) AND (NOT B OR C)

(c) T = 1 if (switch K is ON or switch L is ON) OR (switch K is ON and switch M is OFF) OR (switch M is ON)

(d) X = (A AND NOT B) OR (NOT B AND C)

(e) R = 1 if (switch A is ON and switch B is ON) AND (switch B is ON or switch C is OFF)

(2) Produce the logic circuit and complete a truth table to represent the following scenario. A chemical process is protected by a logic circuit. There are three inputs to the logic circuit representing key parameters in the chemical process. An alarm, X, will give an output value of 1 depending on certain conditions in the chemical process. The following table describes the process conditions being monitored: An alarm, X, will generate the value 1 if: either reaction rate < 40 mol/l/sec or concentration > 4 mol AND temperature > 115°C or reaction rate >= 40 mol/l/sec AND temperature > 115°C

Parameter description	Parameter	Binary value	Description of condition
chemical reaction rate	R	0	reaction rate < 40 mol/l/sec
		1	reaction rate >= 40 mol/l/sec
process temperature	T	0	temperature > 115°C
		1	temperature <= 115°C
concentration of chemicals	C	0	concentration <= 4 mol
		1	concentration > 4 mol

Exam-style questions

1

(a) Produce:

(i) a Boolean or logic expression

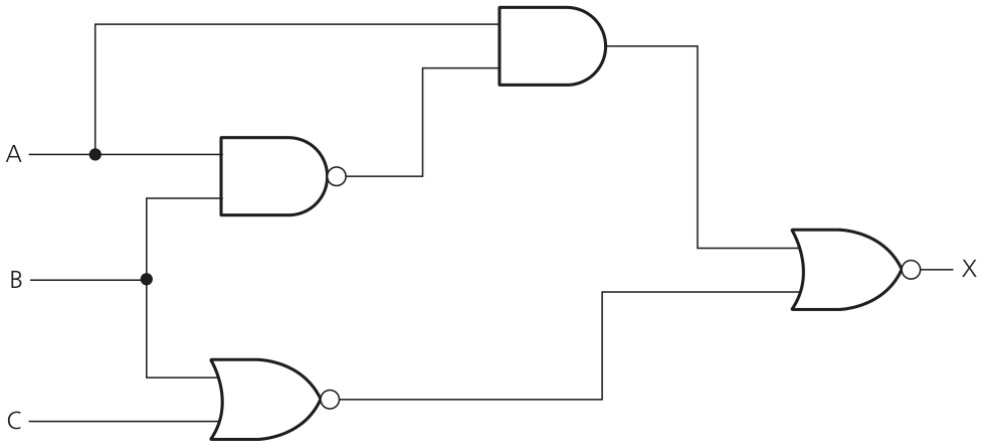
(ii) a logic circuit [4]

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

(b) for the truth table shown: Produce:

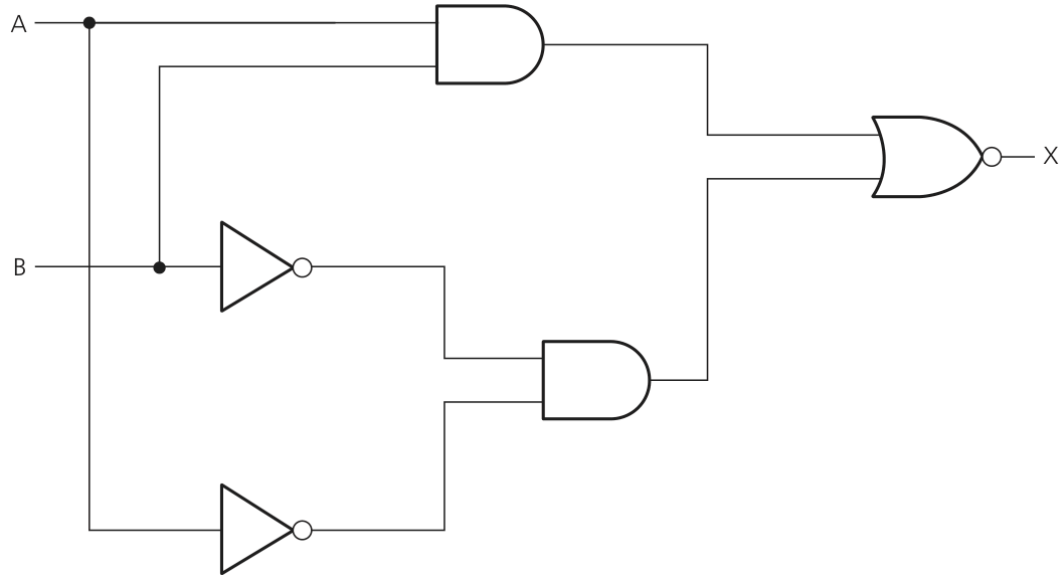
(i) a logic expression

(ii) a truth table for the logic circuit shown below: [6]



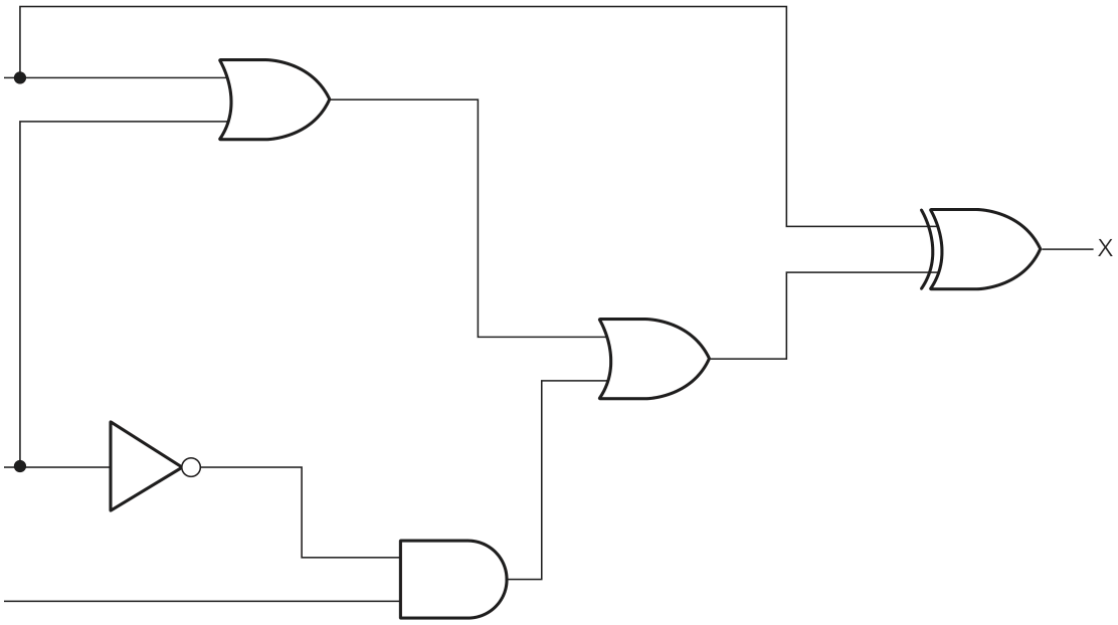
2

(a) Write a logic expression for the following logic circuit: [3]



(b) Draw a logic circuit which represents the following Boolean expression: X = NOT (A AND B) OR (A AND NOT B) [3]

(c) Complete the truth table for the following logic circuit: A B C **[4]**



3 A motor driving a water pump has a safety system which uses three inputs to a logic circuit. A certain combination of conditions results in an output, X, from the logic circuit being equal to 1. When the value of X = 1 then the motor and pump are shut down. The following table shows which parameters are being monitored and form the three inputs to the logic circuit. The output, X, will have a value of 1 if any of the following combination of conditions occur: » **either** motor speed > 2000 rpm and bearing temperature > 90°C » **or** motor speed <= 2000 rpm and water velocity <= 5 m/s » **or** bearing temperature > 90°C and water velocity <= 5 m/s

Parameter description	Parameter	Binary value	Description of condition
motor speed	S	0	motor speed <= 2000 rpm
		1	motor speed > 2000 rpm
bearing temperature	T	0	bearing temperature <= 90°C
		1	bearing temperature > 90°C
water velocity	V	0	water velocity <= 5 m/s
		1	wind velocity > 5 m/s

(a) Design a logic circuit for the above scenario. [7]

(b) Complete a truth table for the above scenario. [4]

4

(a) Write a logic expression for the truth table below.

X	Y	Z
0	0	1
0	1	0
1	0	1
1	1	0

(b) Draw a logic circuit from the above truth table. [4]

5 A factory manufactures plastic pipes. It uses logic circuits to control the manufacturing process.

(a) Consider the logic gate: **Input A Output Input B** Complete the truth table for this logic gate. [1]



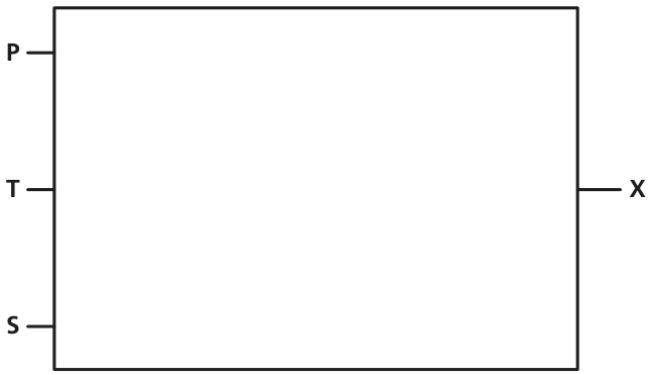
Input A	Input B	Output
0	0	
0	1	
1	0	
1	1	

(b) Consider the truth table: State the **single** logic gate that produces the given output. [1]

Input A	Input B	Output
0	0	0
0	1	1
1	0	1
1	1	0

(c) Plastic pipes of various sizes are manufactured by heating the plastic and using pressure. The manufacturing system uses sensors to measure the pressure (P), temperature (T) and speed (S) of production. The inputs to the manufacturing system are: **or** Draw a logic circuit to represent the above alarm system. Logic gates used must have a maximum of **two** inputs. [5]

Input	Binary value	Condition
P	1	pressure is > 5 bar
	0	pressure is <= 5 bar
T	1	temperature is > 200 degrees Celsius
	0	temperature is <= 200 degrees Celsius
S	1	speed is > 1 metre per second
	0	speed is <= 1 metre per second



(d) The system will sound an alarm (**X**) when certain conditions are detected. The alarm will sound when: temperature is > 200 degrees Celsius and the pressure is <= 5 bar speed is > 1 metre per second and the temperature <= 200 degrees Celsius Give **two** benefits of using sensors to monitor the manufacture of the plastic pipes. [2]

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6 A DVD recorder is protected by three sensors (S, T and P). The output from these sensors forms the inputs to a logic circuit. A certain combination of input values produces an output of 1 from the logic circuit. When this occurs a warning message is shown on the DVD display. The following table shows which parameters are being monitored and form the three inputs to the logic circuit: The output X will have a value of 1 if any of the following combination of conditions occurs: » either rotation speed >= 1000 rpm and tilt angle < 30° » or rotation speed < 1000 rpm and laser power >= 150 mW » or tilt angle >= 30° and laser power < 150 mW

Parameter description	Parameter	Binary value	Description of condition
rotation speed	S	0	rotation speed >= 1000 rpm
		1	rotation speed < 1000 rpm
tilt angle	T	0	tilt angle >= 30°
		1	tilt angle < 30°
laser power	P	0	laser power < 150 mW
		1	laser power >= 150 mW

(a) Write down a logic or Boolean expression for the above system. [2]

(b) Draw a logic circuit to monitor the above system. [6]

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