

Work Sheet Ch4 Logic Circuits

20191120

Q1

- 7 A system is monitored using sensors. The sensors output binary values corresponding to physical conditions, as shown in the table:

Parameter	Description of parameter	Binary value	Description of condition
P	oil pressure	1	pressure \geq 3 bar
		0	pressure $<$ 3 bar
T	temperature	1	temperature \geq 200°C
		0	temperature $<$ 200°C
R	rotation	1	rotation \leq 1000 revs per minute (rpm)
		0	rotation $>$ 1000 revs per minute (rpm)

The outputs of the sensors form the inputs to a logic circuit. The output from the circuit, X, is 1 if any of the following three conditions occur:

either oil pressure \geq 3 bar **and** temperature \geq 200°C

or oil pressure $<$ 3 bar **and** rotation $>$ 1000 rpm

or temperature \geq 200°C **and** rotation $>$ 1000 rpm

- (a) Draw a logic circuit to represent the above system.



[5]

(b) Complete the truth table for this system.

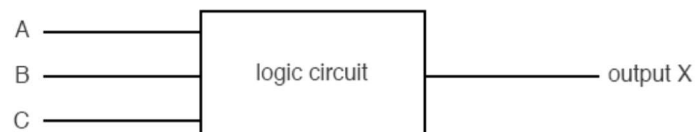
P	T	R	Workspace	X
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

[4]

Q2

- 6 (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.

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.



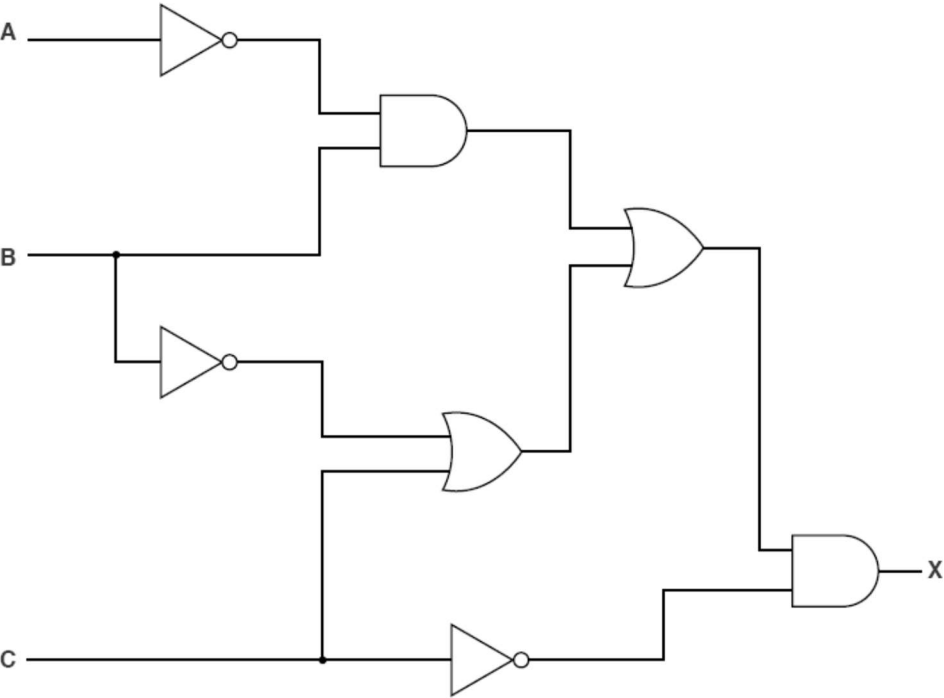
[5]

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

A	B	C	Working Space	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		

[4]

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



.....

.....

.....

..... [3]

Q3

- 1 (a) A student writes the following logic expression:

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.



[6]

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

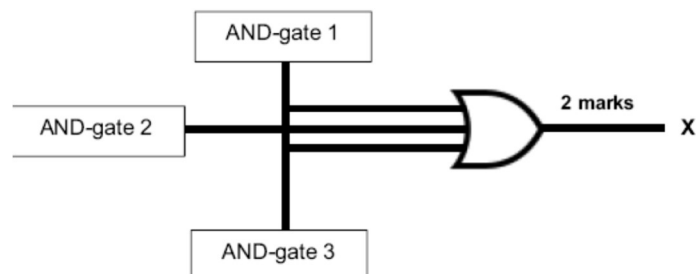
B	S	P	Working space	X
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

[4]

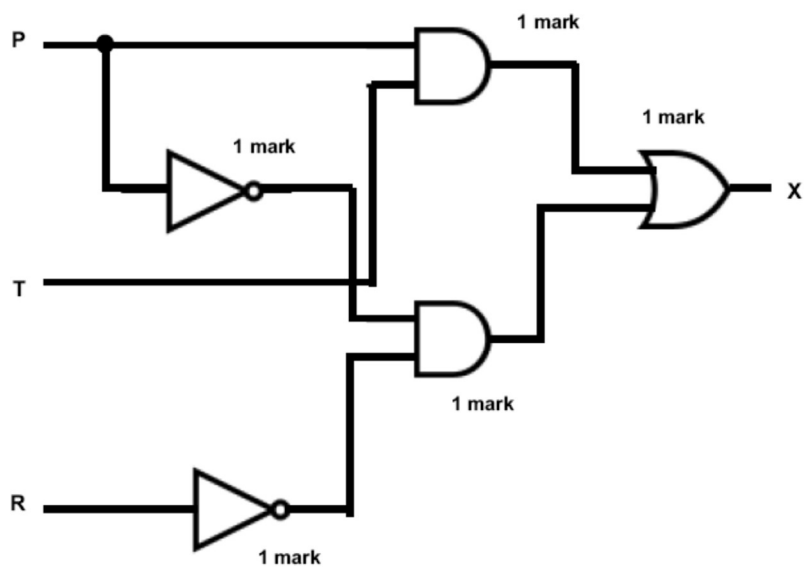
Q1 S15

- [illegible]

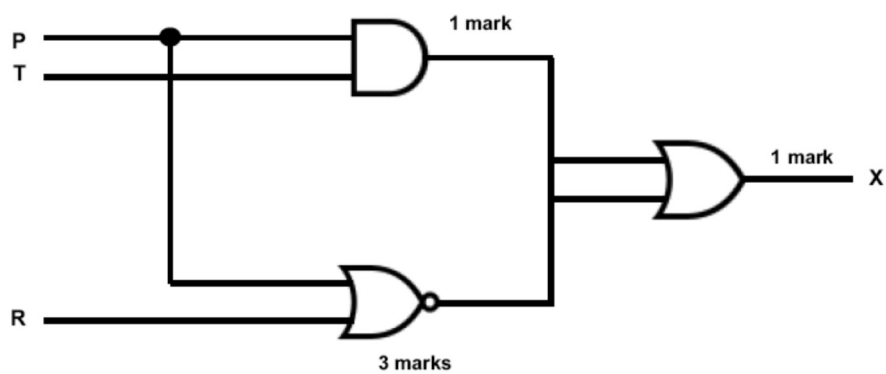
Note: it is possible to use a 3-input OR gate rather than the two 2-input OR gates on the top right:



Alternative solution 1:



Alternative solution 2:



[5]

Note: other solutions may be possible depending on how simplification of the original statement is done

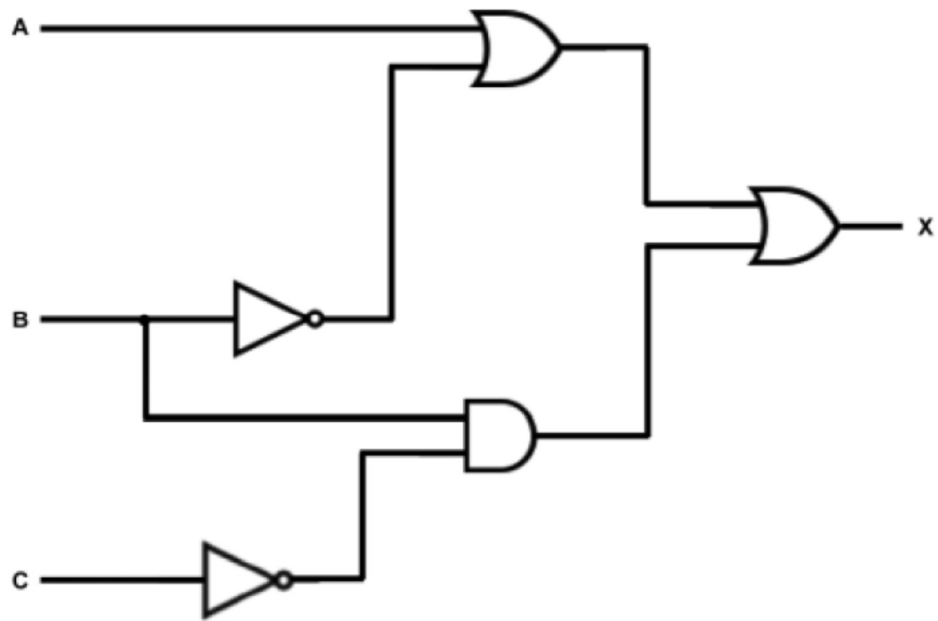
(b)

P	T	R	Workspace	X	
0	0	0		1	} 1 mark
0	0	1		0	
0	1	0		1	} 1 mark
0	1	1		0	
1	0	0		0	} 1 mark
1	0	1		0	
1	1	0		1	} 1 mark
1	1	1		1	

[4]

Q2 S15

6 (a)



[5]

(b)

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

[4]

- (c) ((A is NOT 1 AND B is 1) OR (B is NOT 1 OR C is 1)) AND C is NOT 1
 <----- 1 mark -----> <----- 1 mark -----> <-----1 mark ----->

NOTE: all brackets may not be shown – but check answer still correct

Alternatives include:

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

$(\bar{A} \cdot B + (\bar{B} + C)) \cdot \bar{C}$

NOTE: expressions may be reversed but still OK

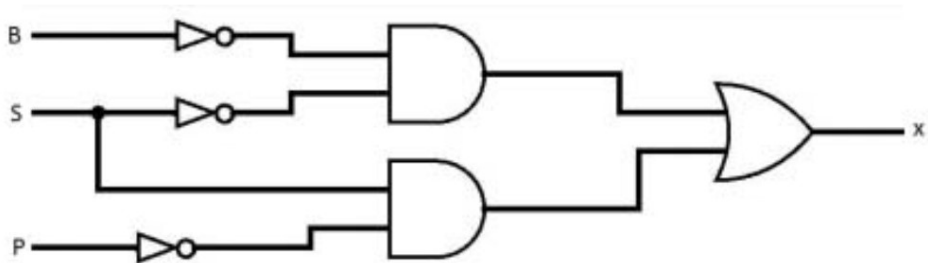
(e.g. NOT C AND ((NOT A AND B) OR (NOT B OR C))

NOT C AND ((NOT B OR C) OR (NOT A AND B)) and so on)

[3]

Q3 W16

- 1 (a) **ONE** mark for each correct gate.



[6]

- (b) **ONE** mark for each pair of rows.

B	S	P	Working space	X
0	0	0		1
0	0	1		1
0	1	0		1
0	1	1		0
1	0	0		0
1	0	1		0
1	1	0		1
1	1	1		0

[4]