(i) $Q = A.\bar{B} + B$

$A + B$

B \ A	0	1
0		1
1	1	1

[2]

Q = ...

(ii) $Q = \bar{A}.B.\bar{C}.\bar{D} + \bar{A}.\bar{B}.\bar{C}.\bar{D} + \bar{B}.\bar{C}.D + B.\bar{C}.D$

$\bar{A}.\bar{C}.\bar{D}(\bar{B}+B) + D\bar{C}.(\bar{B}+B)$

$\overline{A.\bar{C}}\bar{D} + D.\bar{C}$

$\bar{A}.\bar{C}.\bar{D} + D.\bar{C} + \bar{C}.\bar{A}$

$D.\bar{C} + \bar{C}.\bar{A}$

DC \ BA	00	01	11	10
00	1			1
01				
11				
10	1	1	1	1

[3]

Q = $\bar{C}.D + \bar{A}.\bar{C}$

(ii) $Q = A.B + \bar{A}.B.C + \bar{A}.\bar{B}.C + A.\bar{B}.\bar{C}$

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

$A.B + \bar{A}.C + A.\bar{B}.\bar{C}$

$A.B + \bar{A}.C + A.\bar{B}.\bar{C} + A.\bar{C}$

Q = $A.B + \bar{A}.C + A.\bar{C}$ [3]

C \ BA	00	01	11	10
0		1	1	
1	1		1	1

$\bar{C}.A + C.\bar{A} + C.B$

or

$\bar{C}.A + C.\bar{A} + A.B$

11. The following truth table defines the logic conditions for a particular application.

Inputs				**Output**	
D	**C**	**B**	**A**	**Q**	
0	0	0	0	0	
0	0	0	1	0	
0	0	1	0	1	$\bar{A}.B.\bar{C}.\bar{D}$
0	0	1	1	1	$A.B.\bar{C}.\bar{D}$
0	1	0	0	0	
0	1	0	1	0	
0	1	1	0	0	
0	1	1	1	0	
1	0	0	0	1	$\bar{A}.\bar{B}.\bar{C}.D$
1	0	0	1	1	$A.\bar{B}.\bar{C}.D$
1	0	1	0	0	
1	0	1	1	0	
1	1	0	0	1	$\bar{A}.\bar{B}.C.D$
1	1	0	1	1	$A.\bar{B}.C.D$
1	1	1	0	0	
1	1	1	1	0	

Write the simplified Boolean expression for the truth table

why? $B.\bar{C}.\bar{D} + \underbrace{\bar{B}.\bar{C}.D + \bar{B}.C.D}$

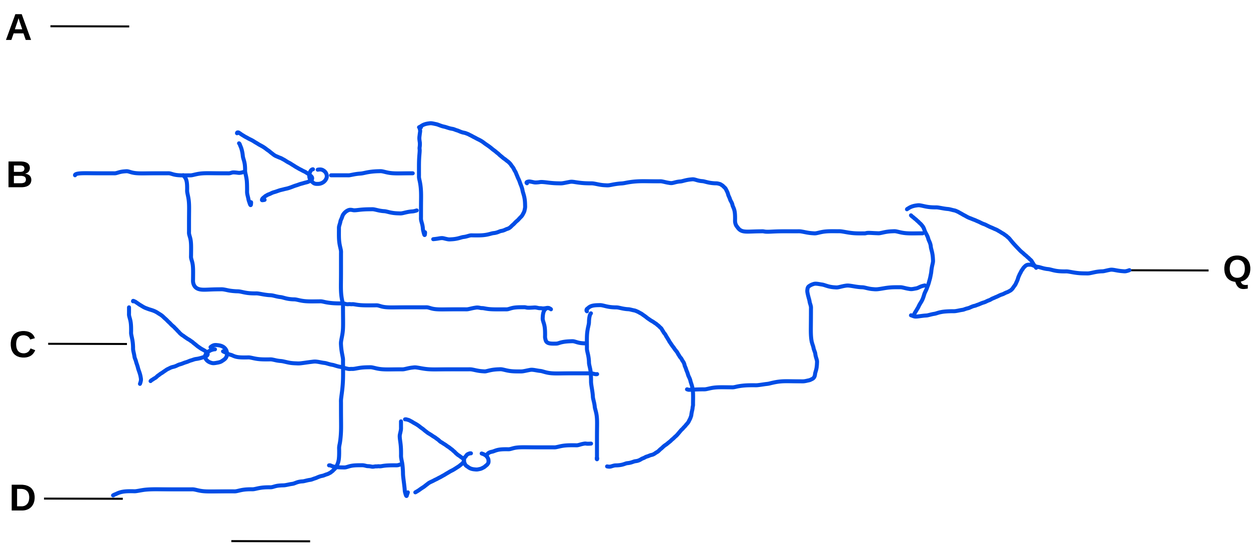
$B.\bar{C}.\bar{D} + \bar{B}.D$

Complete the Karnaugh map below for the same logic function using either the truth table or your logic expression from (a)

$\bar{B}.D + B.\bar{C}.\bar{D}$

DC \ BA	00	01	11	10
00			1	1
01				
11	1	1		
10	1	1		

Draw the circuit



6.

D	C	B	A	Q
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	1
0	1	1	0	0
0	1	1	1	1
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	0
1	1	0	0	0
1	1	0	1	1
1	1	1	0	0
1	1	1	1	1

DC \ BA	00	01	11	10
00				
01		1	1	
11		1	1	
10				

$A \cdot C$

10.

$$Q = \overline{A}.\overline{B}.\overline{C}.\overline{D} + \overline{A}.B.\overline{C}.\overline{D} + \overline{B}.\overline{C}.D + B.\overline{C}.D$$

DC \ BA	00	01	11	10
00	1	1		
01				
11				
10	1	1	1	1

$D \cdot \overline{C} + \overline{C} \cdot \overline{B} = \overline{C} \cdot (D + \overline{B})$

Use the rules of Boolean algebra to join the expression in column 1 to the equivalent expression in column 2 with a line. One has already been done for you.

Column 1	Column 2
$X \cdot \overline{Y} + X \cdot Z$	$\overline{X + \overline{Y}} + X \cdot Z$
$\overline{X} \cdot Y + X \cdot Z$	$\overline{X} \cdot (Y + Z)$
$\overline{X} \cdot Y + \overline{X} \cdot Z$	$\overline{X} \cdot Y + X \cdot Z + Y \cdot Z$
$X \cdot Y + X \cdot Z$	$\overline{\overline{X \cdot \overline{Y}}} + X \cdot Z$
$(X + Y) \cdot (\overline{X} + Z)$	$X \cdot Y + X \cdot Z + \overline{Y} \cdot Y$

$\overline{X} \cdot y + x \cdot z$

$x \cdot \overline{Y} + x \cdot z$

$X \cdot Y + X \cdot Z$

$X \cdot \overline{X} + X \cdot Z + Y \cdot \overline{X} + Y \cdot Z$

$X \cdot Z + Y \cdot \overline{X} + Y Z$

$\bar{v}\cdot y$	$v\cdot\bar{x} + \overline{v + y}$
$\overline{v + x + y}$	$\overline{v\cdot x\cdot y}$
$v\cdot\bar{x} + \bar{v}\cdot\bar{y} + \bar{x}\cdot\bar{y}$	$\bar{v}\cdot\bar{x}\cdot\bar{y}$
$(\overline{\bar{v} + x})\cdot(\bar{v}\cdot y + v\cdot\bar{x}\cdot y)$	$v\cdot\bar{x}\cdot y$
	$v\cdot\bar{x}\cdot y + \bar{v}\cdot x\cdot y$
	$\bar{v}\cdot x\cdot y$
	$\bar{v}\cdot y + \bar{v}\cdot x\cdot y$

$v.\bar{x} + \bar{v}.\bar{y}$

$v.\bar{x} + \bar{v}.\bar{y} + \bar{x}.\bar{y}$

$\bar{v}.y.(1 + x)$

$\bar{v}.y$

$v.\bar{x}.(\bar{v}.y + v.\bar{x}.y)$

$v.\bar{x}.\bar{v}.y + v.\bar{x}.v.\bar{x}.y$

$v\bar{x}.y$

(b) Apply DeMorgan's theorem to the following expression **and** simplify the result.

$$Q = \overline{\overline{(\bar{A}+B)}.A.\bar{B}}$$

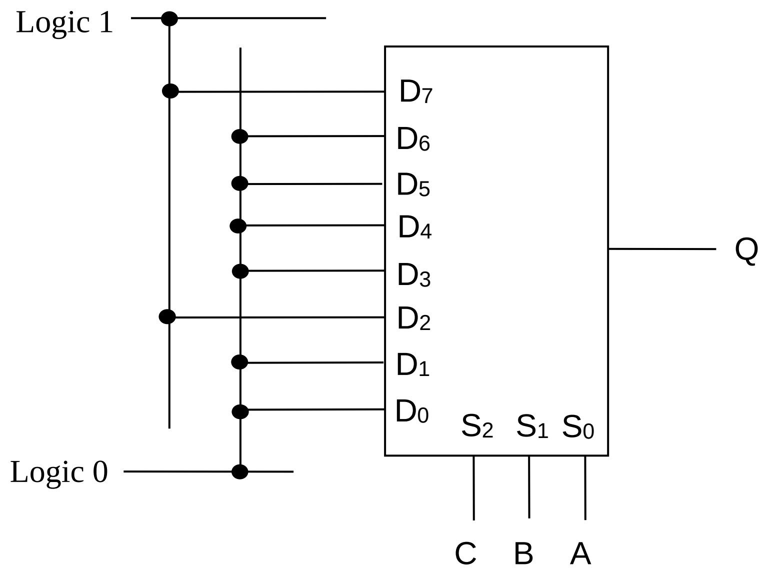
$\overline{\overline{\bar{A}+B}} + \overline{A.\bar{B}}$

$\bar{A} + B + \bar{A} + B$

$\bar{A} + B$

[3]

The diagram shows an 8 : 1 multiplexer used as a programmable logic system.



(a) Complete the truth table for this system.

Inputs			**Output**
C	**B**	**A**	**Q**
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

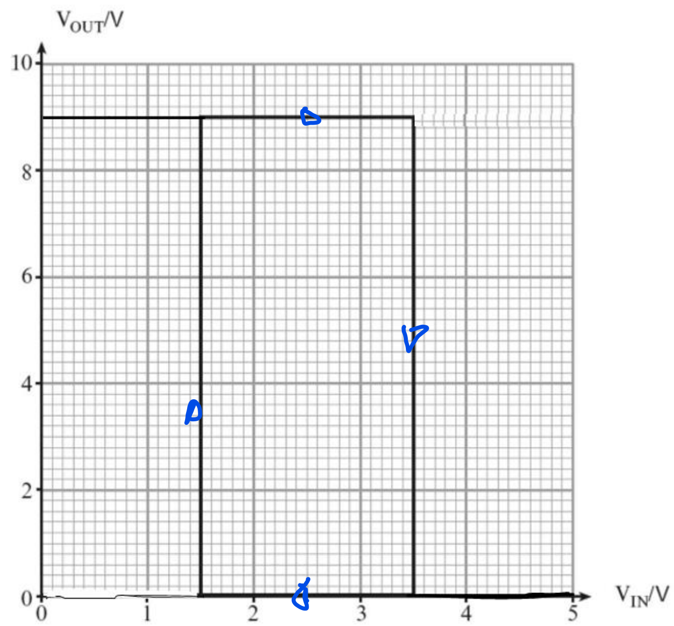
[2]

(b) Write down the Boolean expression for the output **Q**, in terms of **A**, **B** and **C**.

Q = $\overline{A}.B.\overline{C} + A.B.C$

[2]

1. A Schmitt trigger circuit has the following characteristic.

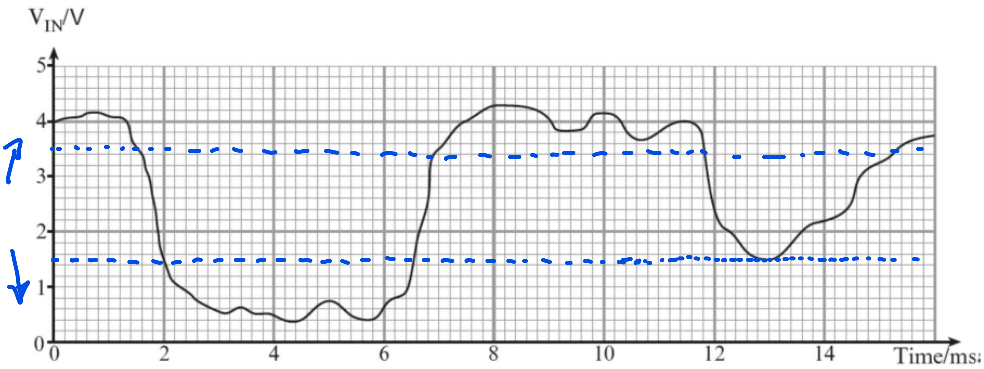


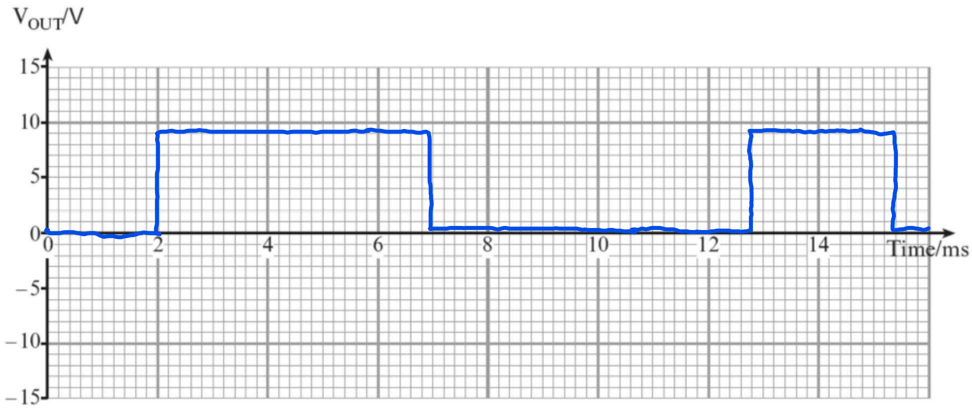
(ii) What are the switching thresholds for this Schmitt trigger?

1.5 .... and .... 3.5 [1]

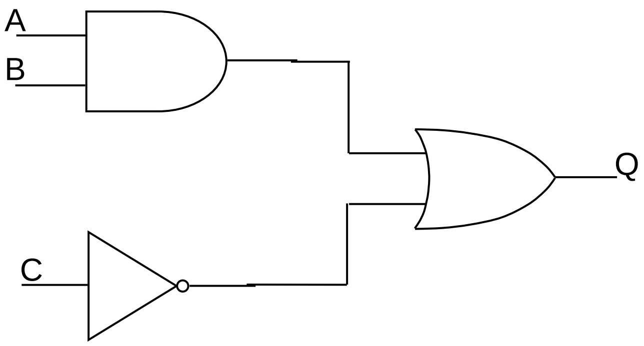
lower upper

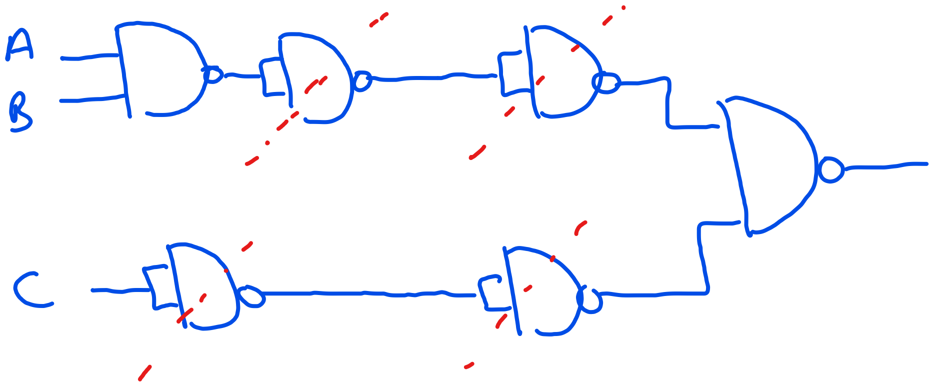
(b) Draw the output for this Schmitt trigger when the following analogue signal is applied to the input. [3]



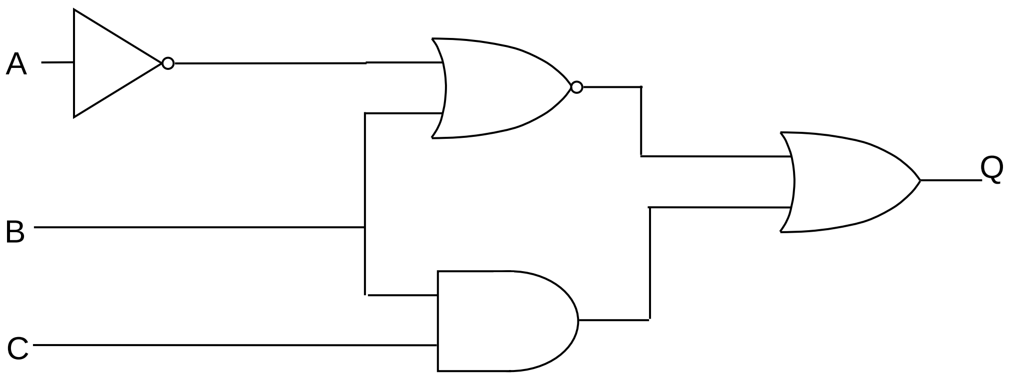


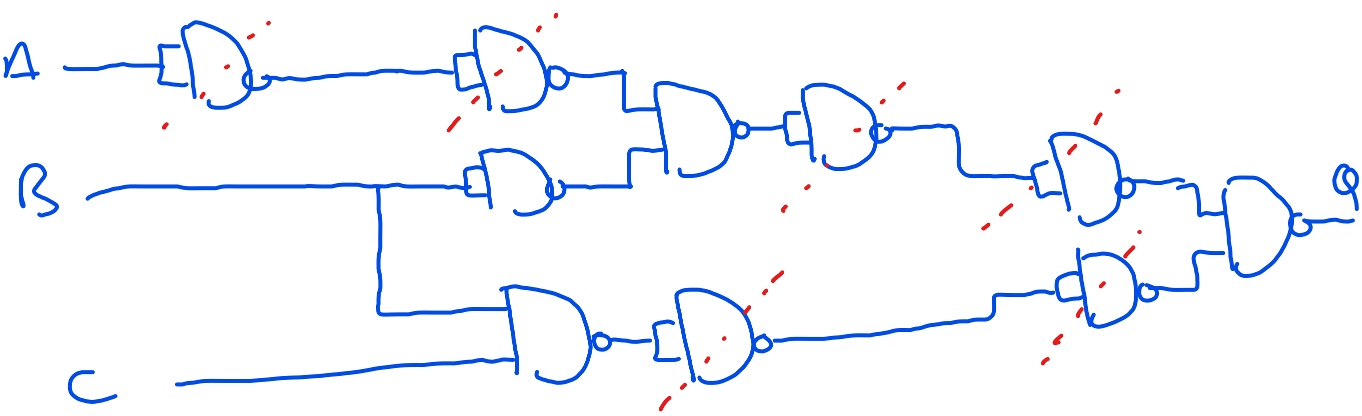
1. (a) Redraw the following logic circuit using 2 input NAND gates only.





2. (a) Redraw the following logic circuit using 2 input NAND gates only.





3. A logic system behaves according to this Boolean expression.

$$Q = C.\overline{B}.A + C.B + \overline{C}.B.\overline{A}$$

(a) Complete the truth table for this system. [1]

C	**B**	**A**	**Q**
0	0	0	
0	0	1	
0	1	0	1
0	1	1	
1	0	0	
1	0	1	1
1	1	0	1
1	1	1	1

(b) Use a Karnaugh map or Boolean algebra to simplify the expression for Q. [3]

$C.A + \overline{A}.B$

C \ BA	00	01	11	10
0	0	0	0	1
1	0	1	1	1

(c) Apply DeMorgan's theorem to the following expression **and** simplify the result. [3]

$$Q = \overline{(\overline{A} + \overline{B}).(\overline{A}.B)}$$

$\overline{\overline{A}+\overline{B}} + \overline{\overline{A}.B}$

$\overline{\overline{A}}.\overline{\overline{B}} + \overline{\overline{A}}+\overline{B}$

$A.B + A+\overline{B}$

$A+\overline{B}$