QUESTION 5.

5 (a) (i) Complete the Boolean function that corresponds to the following truth ta…

INPUT			OUTPUT
A	B	C	X
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1

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

The part to the right of the equals sign is known as the sum-of-products.

(ii) For the truth table above complete the Karnaugh Map (K-map).

		AB			
		00	01	11	10
C	0	0	0	1	0
	1	0	1	1	0

AB

BC

· Large groups
· fewer no. of groups

[1]

The K-map can be used to simplify the function in **part(a)(i)**.

(iii) Draw loop(s) around appropriate groups of 1's to produce an optimal sum-of-products. [2]

(iv) Using your answer to **part (a)(iii)**, write the simplified sum-of-products Boolean function.

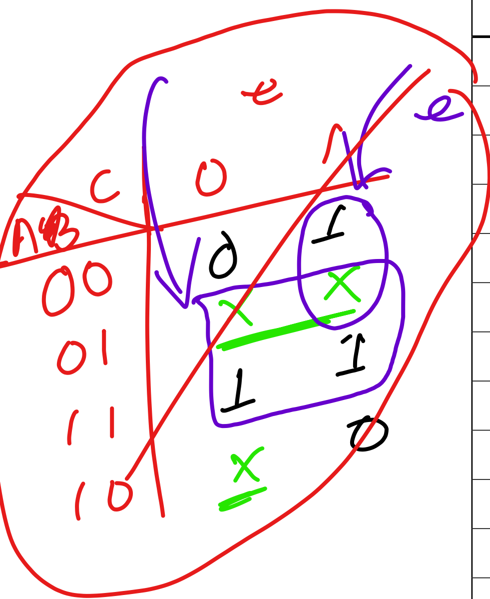
X = BC+AB ....[2]

B(A+C)

S.O.P

P.O.S

(b) The truth table for a logic circuit with four inputs is given below:



INPUT				OUTPUT
A	**B**	**C**	**D**	**X**
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	1
0	1	0	1	0
0	1	1	0	1
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	0
1	1	0	0	1
1	1	0	1	0
1	1	1	0	1
1	1	1	1	1

0100
0110
1100
1110
1111

(i) Complete the K-map corresponding to the truth table above.

ABCD
0100
0110
1100
1110
$B \cdot \bar{D}$

1111
1110
ABC

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

[4]

(ii) Draw loop(s) around appropriate groups of 1's to produce an optimal sum-of-products. [2]

(iii) Using your answer to **part (b)(ii)**, write the simplified sum-of-products Boolean function.

X = $A \cdot BC + B \cdot \bar{D}$ [2]

QUESTION 6.

5 **(a)** **(i)** Complete the Boolean function that corresponds to the following truth ta

INPUT			OUTPUT
P	**Q**	**R**	**Z**
0	0	0	0
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	1

$Z = P \,.\, \overline{Q} \,.\, \overline{R} +$ ....[3]

The part to the right of the equals sign is known as the sum-of-products.

(ii) For the truth table above complete the Karnaugh Map (K-map).

		PQ			
		00	**01**	**11**	**10**
R	**0**				
	1				

[1]

The K-map can be used to simplify the function in **part(a)(i)**.

(iii) Draw loop(s) around appropriate groups of 1's to produce an optimal sum-of-products. [2]

(iv) Using your answer to **part (a)(iii)**, write the simplified sum-of-products Boolean function.

Z = ...[1]

(b) The truth table for a logic circuit with four inputs is given below:

INPUT				OUTPUT
P	**Q**	**R**	**S**	**Z**
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	1
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

(i) Complete the K-map corresponding to the truth table above.

PQ

RS

[4]

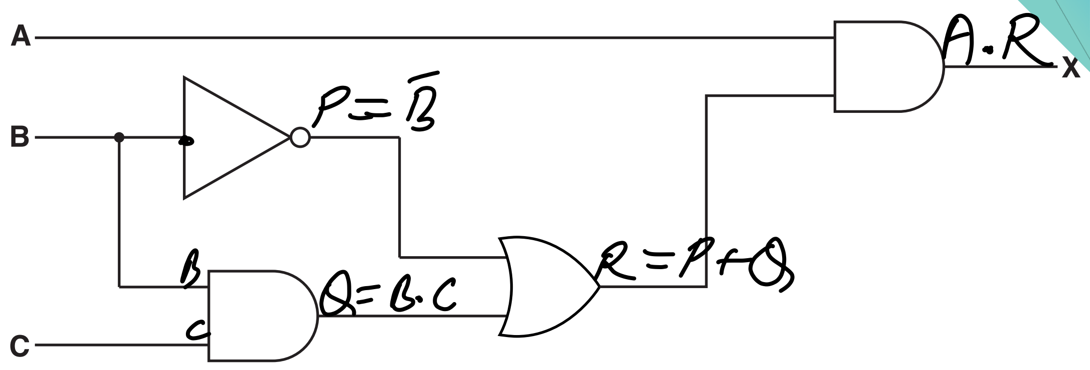
(ii) Draw loop(s) around appropriate groups of 1's to produce an optimal sum-of-products. [2]

(iii) Using your answer to **part (b)(ii)**, write the simplified sum-of-products Boolean function.

Z = ...[2]

QUESTION 7.

3 Consider the following logic circuit, which contains a redundant logic gate.



(a) Write the Boolean algebraic expression corresponding to this logic circuit.

X = $A.(\overline{B} + B.C)$ ....[3]

(b) Complete the truth table for this logic circuit.

A	B	C	P	Working space Q	R	X
0	0	0	1	0	1	0
0	0	1	1	0	1	0
0	1	0	0	0	0	0
0	1	1	0	1	1	0
1	0	0	1	0	1	1
1	0	1	1	0	1	1
1	1	0	0	0	0	0
1	1	1	0	1	1	1

[2]

(c) **(i)** Complete the Karnaugh Map (K-map) for the truth table in **part (b)**.

		AB 00	01	11	10
C	0				
	1				

[1]

The K-map can be used to simplify the expression in **part (a)**.

(ii) Draw loop(s) around appropriate groups to produce an optimal sum-of-products. [2]

(iii) Write a simplified sum-of-products expression, using your answer to **part (ii)**.

X = ...[2]

(d) One Boolean identity is:

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

Simplify the expression for X in **part (a)** to the expression for X in **part (c)(iii)**. You shou[...] the given identity.

$A\overline{B} + ABC$

$A(\overline{B} + BC)$

$A(B + C) = AB + AC$

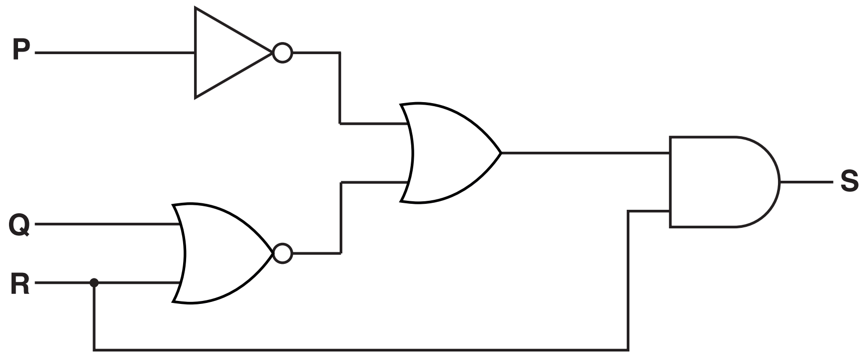
[2]

common

rule

QUESTION 8.

3 A logic circuit is shown:



(a) Write the Boolean algebraic expression corresponding to this logic circuit:

S = ...[4]

(b) Complete the truth table for this logic circuit:

P	Q	R	Working space	S
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

[2]

(c) **(i)** Complete the Karnaugh Map (K-map) for the truth table in **part (b)**.

		PQ			
		00	**01**	**11**	**10**
R	**0**				
	1				

[1]

The K-map can be used to simplify the function in **part (a)**.

(ii) Draw loop(s) around appropriate groups to produce an optimal sum-of-products. [1]

(iii) Write a simplified sum-of-products expression, using your answer to **part (ii)**.

S = ...[1]

(d) One Boolean identity is:

$$(A + B) . C = A . C + B . C$$

Simplify the expression for S in **part (a)** to the expression for S in **part (c)(iii)**.

You should use the given identity and De Morgan's Laws.

....

....

....

....

....

....

....

....[3]

QUESTION 9.

4 **(a)** A Boolean expression corresponds to the following truth table.

INPUT			OUTPUT
A	**B**	**C**	**X**
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

(i) Write the Boolean expression for the truth table by applying the sum-of-products.

X = ...[2]

(ii) Complete the Karnaugh Map (K-map) for the truth table.

AB

C		**00**	**01**	**11**	**10**
	0				
	1				

[1]

(iii) The K-map can be used to simplify the expression in **part (a)(i)**.

Draw loop(s) around appropriate groups of 1s in the table in **part (a)(ii)** to produce an optimal sum-of-products. [3]

(iv) Write the simplified sum-of-products expression for your answer to **part (a)(iii)**.

X = ...[3]

(b) A logic circuit with four inputs produces the following truth table.

INPUT				OUTPUT
A	**B**	**C**	**D**	**X**
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	1
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	0
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

(i) Complete the K-map that corresponds to the truth table.

AB

CD

[4]

(ii) Draw loop(s) around appropriate groups of 1s in the table in **part (b)(i)** to produce an optimal sum-of-products. [2]

(iii) Write the simplified sum-of-products expression for your answer to **part (b)(ii)**.

X = ...[2]

QUESTION 10.

3 **(a)** Consider the following Boolean expression.

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

Use Boolean algebra to simplify the expression.

....

....

....

....

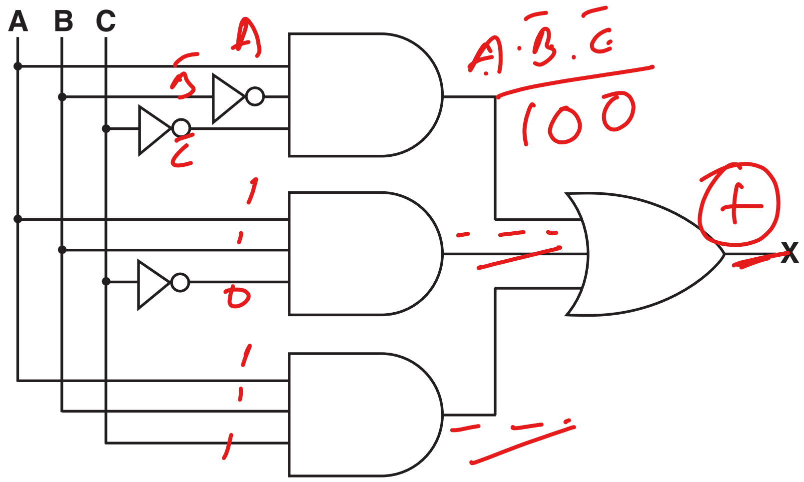
....

....

....

....[4]

(b) **(i)** Complete the truth table for the following logic circuit.



A	B	C	Working space	X
0	0	0		
0	0	1		
0	1	0		
0	1	1	Shown in diagram	
1	0	0		1
1	0	1		
1	1	0		1
1	1	1		1

[2]

(ii) Complete the Karnaugh Map (K-map) for the truth table in **part (b)(i)**.

		AB			
		00	**01**	**11**	**10**
C	**0**				
	1				

[1]

(iii) Draw loops around appropriate groups of 1s in the table in **part (b)(ii)** to produce an optimal sum-of-products. [2]

(iv) Using your answer to **part (b)(iii)**, write a simplified sum-of-products Boolean expression.

X = ...[2]

(c) The truth table for a logic circuit with four inputs is shown.

INPUT				OUTPUT
A	**B**	**C**	**D**	**X**
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	1
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	0
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

(i) Complete the K-map for the truth table in **part (c)**.

AB

CD

[4]

(ii) Draw loops around appropriate groups of 1s in the table in **part (c)(i)** to produce an optimal sum-of-products. [2]

(iii) Using your answer to **part (c)(ii)**, write a simplified sum-of-products Boolean expression.

X = ...[2]

QUESTION 11.

3 **(a)** A Boolean algebraic expression produces the following truth table.

INPUT			**OUTPUT**
A	**B**	**C**	**X**
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0

(i) Complete the Karnaugh Map (K-map) for the truth table.

AB

		00	**01**	**11**	**10**
C	**0**				
	1				

[1]

The K-map can be used to simplify the expression that produced the truth table in **part (a)**.

(ii) Draw loops around appropriate groups of 1s in the K-map to produce an optimal sum-of-products. [2]

(iii) Write the simplified sum-of-products Boolean expression for the truth table.

X = ... [2]

(b) A logic circuit with four inputs produces the following truth table.

INPUT				OUTPUT
A	**B**	**C**	**D**	**X**
0	0	0	0	0
0	0	0	1	0
0	0	1	0	1
0	0	1	1	1
0	1	0	0	0
0	1	0	1	0
0	1	1	0	1
0	1	1	1	1
1	0	0	0	1
1	0	0	1	1
1	0	1	0	0
1	0	1	1	0
1	1	0	0	1
1	1	0	1	1
1	1	1	0	0
1	1	1	1	0

← 0010
← 0011
← 0110
← 0111
← 1000
← 1001
← 1100
← 1101

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

↓

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

(i) Complete the K-map for the truth table.

AB

CD	00	01	11	10
00	0	0	1	1
01	0	0	1	1
11	1	1	0	0
10	1	1	0	0

1100
1000
1101
1001

$A\bar{C}$

0011
0111
0010
0110

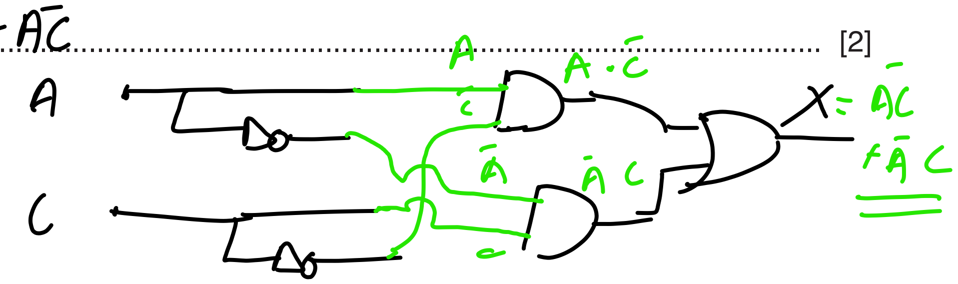
$\bar{A}C$

[4]

(ii) Draw loops around appropriate groups of 1s in the K-map to produce an optimal sum-of-products. [2]

(iii) Write the simplified sum-of-products Boolean algebraic expression for the truth table.

X = $\bar{A}C + A\bar{C}$ .... [2]



QUESTION 12.

4 A Boolean expression produces the following truth table.

INPUT			OUTPUT
A	**B**	**C**	**X**
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1

(a) Write the Boolean expression for the truth table as a sum-of-products.

X = ... [2]

(b) Complete the Karnaugh Map (K-map) for the truth table above.

AB

		00	**01**	**11**	**10**
C	**0**				
	1				

[1]

The K-map can be used to simplify the expression in **part (a)**.

(c) Draw loops around appropriate groups in the K-map in **part (b)** to produce an optimal sum-of-products. [2]

(d) Write, using your answer to **part (c)**, a simplified sum-of-products expression for the truth table.

X = ... [2]

QUESTION 13.

2 (a) A Boolean expression produces the following truth table.

INPUT			OUTPUT
A	**B**	**C**	**X**
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0

(i) Write the Boolean expression for the truth table by applying the sum-of-products.

X = ...

.... [3]

(ii) Complete the Karnaugh Map (K-map) for the truth table in **part (a)**.

AB

		00	01	11	10
C	**0**				
	1				

[1]

The K-map can be used to simplify the function in **part (a)(i)**.

(iii) Draw loop(s) around appropriate groups in the table in **part (a)(ii)**, to produce an optimal sum-of-products. [2]

(iv) Write, using your answer to **part (a)(iii)**, a simplified Boolean expression for your Karnaugh map.

X = ... [2]

(b) Simplify the following expression using De Morgan's laws. Show your workin

$$\overline{(\overline{W} + X) \cdot (Y + \overline{Z})}$$

$= \overline{(\overline{W}+X)} + \overline{(Y+\overline{Z})}$

$= (\overline{\overline{W}} \cdot \overline{X}) + (\overline{Y} \cdot \overline{\overline{Z}})$

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

[3]

- $\overline{(A+B)} = \overline{A} \cdot \overline{B}$
- $\overline{(A \cdot B)} = \overline{A} + \overline{B}$