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Email: [hello@contoureducation.com.au](mailto:hello@contoureducation.com.au)

## VCE Specialist Mathematics ½

### Logic & Algorithms II [2.5]

#### Homework

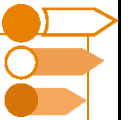
#### Homework Outline:

|                         |              |
|-------------------------|--------------|
| Compulsory Questions    | Pg 2 - Pg 12 |
| Supplementary Questions | Pg 13- Pg 22 |



## Section A: Compulsory Questions

### Sub-Section [2.5.1]: Understand the Basics of Logic and Propositional Statements



#### Question 1



Translate the following to English:

$A$  = I study hard.

$B$  = I understand the material.

$C$  = I will pass the course.

$$A \wedge B \Rightarrow C$$

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**Question 2**


Translate the following to English:

$J$  = I keep my phone charged.

$K$  = I am reachable.

$L$  = There is an emergency.

$$\neg J \wedge L \Rightarrow \neg K$$

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**Question 3**


Translate into propositional logic using correct syntax:

If the student studies diligently, then he will pass the exam and not need a retake.

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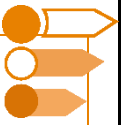
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## Sub-Section [2.5.2]: Construct Truth Tables and Recognise Equivalent Logical Expressions

### Question 4



Write the truth table for:

$$\sim(p \vee q)$$

### Question 5



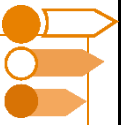
Write the truth table for:

$$(p \wedge q) \vee \sim q$$

**Question 6**


Construct a truth table for the statement  $(p \vee q) \wedge \neg r$ .

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## Sub-Section [2.5.3]: Represent Logical Expressions using Switching Circuits and Logic Gates

### Question 7



Consider the expression:

$$(a \wedge \neg b) \vee (c \wedge \neg a)$$

Draw the switching circuit that is represented by this expression.

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**Question 8**


Use logic gates to represent the following expression and draw the corresponding truth table:

$$p \Rightarrow q$$

**Question 9**


Use logic gates to represent the following expression and draw the corresponding truth table:

$$\neg p \vee \neg q$$

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## Sub-Section [2.5.4]: Simplify and Evaluate Boolean Algebra Expressions using Algebraic Identities and Karnaugh Maps

### Question 10



Simplify each expression by algebraic manipulation.

a.  $a + 0 =$

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b.  $a + \bar{a} =$

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c.  $a + ab =$

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### Question 11



Simplify each expression by algebraic manipulation.

a.  $a(\bar{a} + b) =$

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b.  $ab + \bar{a}b =$

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c.  $a(a + b + c) =$

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### Question 12



Simplify each expression by algebraic manipulation where  $f(a, b, c) = a + b + c$ .

a.  $f(a, b, ab) =$

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b.  $f(a, b, \bar{a} \cdot \bar{b}) =$

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c.  $f[a, b, (\overline{ab})] =$

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**Question 13**

Using a Karnaugh map, identify the Boolean expression corresponding to each of the following truth tables.

**a.**

| A | B | C | Result |
|---|---|---|--------|
| 0 | 0 | 0 | 0      |
| 0 | 0 | 1 | 0      |
| 0 | 1 | 0 | 0      |
| 0 | 1 | 1 | 1      |
| 1 | 0 | 0 | 1      |
| 1 | 0 | 1 | 1      |
| 1 | 1 | 0 | 0      |
| 1 | 1 | 1 | 1      |

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**b.**

| A | B | C | Result |
|---|---|---|--------|
| 0 | 0 | 0 | 0      |
| 0 | 0 | 1 | 0      |
| 0 | 1 | 0 | 1      |
| 0 | 1 | 1 | 1      |
| 1 | 0 | 0 | 1      |
| 1 | 0 | 1 | 0      |
| 1 | 1 | 0 | 1      |
| 1 | 1 | 1 | 1      |

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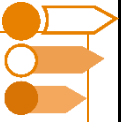
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## Sub-Section: The 'Final Boss'

### Question 14

A traffic control system at an intersection is designed to activate a warning signal based on the status of three road sensors ( $A, B, C$ ). Each sensor detects whether a vehicle is present (1) or absent (0). If at least two of the three sensors detect vehicles (i.e., receive a '1' signal), the warning light turns on (1) to alert drivers. Otherwise, the light remains off (0).

- a.** Construct a truth table with entries 0s and 1s that describes the operation of the traffic light control system.

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- b.** Derive a Boolean expression for the traffic light based on your truth table from **part a**.

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c. Use a Karnaugh map to simplify the Boolean expression obtained in **part b**.

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d. Draw a logic circuit for the traffic light system using logic gates, based on your simplified Boolean expression from **part c**.

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## Section B: Supplementary Questions

### Sub-Section [2.5.1]: Understand the Basics of Logic and Propositional Statements



#### Question 15



Translate the following to English:

$P$  = I eat healthy.

$Q$  = I exercise regularly.

$R$  = I will lose weight.

$$P \wedge Q \Rightarrow R$$

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#### Question 16



Translate the following to English:

$A$  = I go jogging.

$B$  = The weather is good.

$C$  = I will feel energised.

$$\neg B \Rightarrow (\neg A \wedge \neg C)$$

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**Question 17**


Translate into propositional logic using correct syntax:

If the team wins the match, then the fans will celebrate and the opposing team will be disappointed.

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**Question 18**


Translate into propositional logic using correct syntax:

If the baker uses old flour, then the bread will not rise and the customers will complain.

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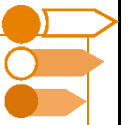
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## Sub-Section [2.5.2]: Construct Truth Tables and Recognise Equivalent Logical Expressions

### Question 19



Write the truth table for:

$$\sim p \vee q$$

### Question 20



Write the truth table for:

$$(p \wedge q) \vee (p \vee q)$$

**Question 21**

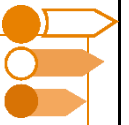

Construct a truth table for the statement  $(p \oplus q) \Rightarrow r$ , where  $\oplus$  is the exclusive or.

**Question 22**


Construct a truth table for the statement  $\neg(p \wedge q) \oplus r$ .

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## Sub-Section [2.5.3]: Represent Logical Expressions using Switching Circuits and Logic Gates

### Question 23



Use logic gates to represent the following expression and draw the corresponding truth table:

$$p \wedge \neg q$$

### Question 24



Use logic gates to represent the following expression and draw the corresponding truth table:

$$\neg(p \wedge q)$$

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**Question 25**


Sketch a logic gate for the following expression:

$$A(B + CD)$$

**Question 26**


Sketch a logic gate for the following expression:

$$[A(C + D)]' + BE$$

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## Sub-Section [2.5.4]: Simplify and Evaluate Boolean Algebra Expressions using Algebraic Identities and Karnaugh Maps

### Question 27



Simplify each expression by algebraic manipulation.

a.  $\bar{a} \cdot 0 =$

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b.  $a + a =$

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c.  $a + \bar{a}b =$

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### Question 28



Simplify each expression by algebraic manipulation.

a.  $y + y\bar{y} =$

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b.  $xy + x\bar{y} =$

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c.  $\bar{x} + y\bar{x} =$

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### Question 29



Simplify each expression by algebraic manipulation.

a.  $(w + \bar{x} + y + \bar{z})y =$

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b.  $(x + \bar{y})(x + y) =$

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c.  $w + (w\bar{x}yz) =$

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Question 30



Simplify the following expression by algebraic manipulation:

$$(x + z)(\bar{x} + y)(z + y) =$$

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Question 31



Using a Karnaugh map, identify the Boolean expression corresponding to each of the following truth tables:

a.

| A | B | C | Result |
|---|---|---|--------|
| 0 | 0 | 0 | 0      |
| 0 | 0 | 1 | 1      |
| 0 | 1 | 0 | 0      |
| 0 | 1 | 1 | 0      |
| 1 | 0 | 0 | 1      |
| 1 | 0 | 1 | 1      |
| 1 | 1 | 0 | 1      |
| 1 | 1 | 1 | 1      |

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b.

| A | B | C | Result |
|---|---|---|--------|
| 0 | 0 | 0 | 0      |
| 0 | 0 | 1 | 0      |
| 0 | 1 | 0 | 1      |
| 0 | 1 | 1 | 0      |
| 1 | 0 | 0 | 1      |
| 1 | 0 | 1 | 0      |
| 1 | 1 | 0 | 1      |
| 1 | 1 | 1 | 0      |

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