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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.

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

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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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. $a + 0 =$

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

c. $a + ab =$

Question 11

Simplify each expression by algebraic manipulation.

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

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

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

Question 12

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

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

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

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

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

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.

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

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

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.

$$P \wedge Q \Rightarrow R$$

Question 16

Translate the following to English:
A = I go jogging.
B = The weather is good.
C = I will feel energised.

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

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.

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

b. $a + a =$

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

Question 28

Simplify each expression by algebraic manipulation.

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

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

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

Question 29

Simplify each expression by algebraic manipulation.

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

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

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

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Question 30

Simplify the following expression by algebraic manipulation:

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

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

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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