



## Boolean Algebra & Logic gates -A/L ICT

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01.

A market gardener wants to install an automatic watering system for his green house to ensure that his plants do not suffer from a lack of water and fertilizer. The system however, must have some safeguards whereby plants should only be **watered when the soil is dry or the fertilizer is insufficient and the door to the greenhouse is closed.**

The following sensors are available:

A moisture sensor (A) which outputs a Logic 0 when dry, and Logic 1 when wet.

A fertilizer sensor (B) which outputs a Logic 1 when sufficient fertilizer, and Logic 0 when insufficient fertilizer.

A door switch (C) which outputs a Logic 0 when closed and Logic 1 when open.

(a) Construct a truth table.

(b) Write down a Boolean expression in standard SOP (Sum-Of-Product) form.

(c) Simplify the Boolean expression obtained in (b). [Show all the workings and algebraic rules].

(d) Draw the logic circuit diagram for the simplified Boolean expression obtained in (c).

02.

An electronic system will only operate if three switches A, B and C are correctly set. An output signal ( $X = 1$ ) will occur if A and B are both in the ON position or if A is in the OFF position and B and C are both in the ON position.

Input	Binary values	Condition
A	1	Switch A in the ON position.
	0	Switch A in the OFF position.
B	1	Switch B in the ON position.
	0	Switch B in the OFF position.
C	1	Switch C in the ON position.
	0	Switch C in the OFF position.

**Output:** Binary 1 for Signal occurs. Binary 0 for Signal does not occur.

(a) Write down the Boolean expression.

(b) Construct the truth table for the Boolean expression obtained in (a).

(c) Draw the logic circuit for the Boolean expression obtained in (a).

(d) Write down the Boolean expression obtained in (a) in SOP (Sum-Of-Product) standard.

(e) A student says that this electronic system will only function if switch B is in the ON position. Justify your answer.

03.

A nuclear power station has a safety system based on three inputs to a logic circuit. A warning signal ( $S = 1$ ) is produced when certain conditions in the nuclear power station occur based on these three inputs.

<i>Input</i>	<i>Binary values</i>	<i>Plant status</i>
A	<i>1</i>	Temperature $> 115^{\circ}\text{C}$
	<i>0</i>	Temperature $\leq 115^{\circ}\text{C}$
B	<i>1</i>	Pressure $> 15$ bar
	<i>0</i>	Pressure $\leq 15$ bar
C	<i>1</i>	Cooling water $> 120$ litres / hour
	<i>0</i>	Cooling water $\leq 120$ litres / hour

A warning signal ( $S = 1$ ) will be produced when any of the following occurs:

*Either Temperature A  $> 115^{\circ}\text{C}$  and Cooling water C  $\leq 120$  litres /hour or Temperature A  $\leq 115^{\circ}\text{C}$  and Reactor pressure B  $> 15$  bar or Cooling water C  $\leq 120$  litres /hour.*

- (a) Write down the Boolean expression.
- (b) Draw the logic circuit for the Boolean expression obtained in (a) using AND, OR and NOT gates only.
- (c) Construct the truth table for the Boolean expression obtained in (a).
- (d) Write down the Boolean expression obtained in (a) in SOP (Sum-Of-Product) standard.

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