CPSC 121 Sample Quiz 1

Name: _____ Student ID: _____
Signature: _____

– You have 20 minutes to write the 2 questions on this examination. A total of 20 marks are available.

– **Justify all of your answers.**

– No notes or electronic equipment are allowed.

– Keep your answers short. If you run out of space for a question, you have written too much.

– The number in square brackets to the left of the question number indicates the number of marks allocated for that question. Use these to help you determine how much time you should spend on each question.

– Use the back of the pages for your rough work.

– **Good luck!**

Question	Marks
1	
2	
Total	

UNIVERSITY REGULATIONS:

– Each candidate should be prepared to produce, upon request, his/her library card.

– No candidate shall be permitted to enter the examination room after the expiration of one half hour, or to leave during the first half hour of the examination.

– CAUTION: candidates guilty of any of the following, or similar, dishonest practices shall be immediately dismissed from the examination and shall be liable to disciplinary action.

1. Having at the place of writing, or making use of, any books, papers or memoranda, electronic equipment, or other memory aid or communication devices, other than those authorised by the examiners.
2. Speaking or communicating with other candidates.
3. Purposely exposing written papers to the view of other candidates. The plea of accident or forgetfulness shall not be received.

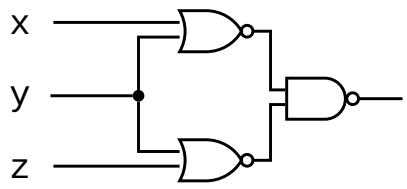
– Candidates must not destroy or mutilate any examination material; must hand in all examination papers; and must not take any examination material from the examination room without permission of the invigilator.

[12] 1. Propositional Logic and Circuits

[3] a. Using a sequence of known logical equivalences (not a truth table), prove that $\rightarrow$ distributes over $\wedge$. That is, prove that $p \rightarrow (q \wedge r) \equiv (p \rightarrow q) \wedge (p \rightarrow r)$.

[3] b. Does $\wedge$ distribute over $\rightarrow$? That is, is $p \wedge (q \rightarrow r)$ logically equivalent to $(p \wedge q) \rightarrow (p \wedge r)$? Explain why or why not.

[6] c. Prove that the output of the following circuit is logically equivalent to $x \vee y \vee z$.



[8] 2. Design a circuit that takes as input a four-bit unsigned integer $a_3a_2a_1a_0$, and outputs 1 if that integer is divisible by 3. **Show your work**: we need to understand how you designed your circuit and why you believe it computes the correct answer. Hint: do **not** try to implement binary division. Instead, use the fact that there are only a few values for which your circuit should output 1.

A working circuit will be worth at least 6 marks out of 8. To get full marks, your circuit will also need to be reasonably elegant (a solution with only 7 gates exists).

Name	Rule(s)
Commutative	$p \wedge q \equiv q \wedge p$ $p \vee q \equiv q \vee p$
Associative	$p \wedge (q \wedge r) \equiv (p \wedge q) \wedge r$ $p \vee (q \vee r) \equiv (p \vee q) \vee r$
Distributive	$p \wedge (q \vee r) \equiv (p \wedge q) \vee (p \wedge r)$ $p \vee (q \wedge r) \equiv (p \vee q) \wedge (p \vee r)$
Absorption	$p \vee (p \wedge q) \equiv p$ $p \wedge (p \vee q) \equiv p$
Negation	$p \wedge \sim p \equiv F$ $p \vee \sim p \equiv T$
De Morgan's	$\sim (p \wedge q) \equiv (\sim p) \vee (\sim q)$ $\sim (p \vee q) \equiv (\sim p) \wedge (\sim q)$