Term: Winter 2024

Instructor: Patricia Wrean

Name: Solution Set

MATH 156
Test 2, Version A

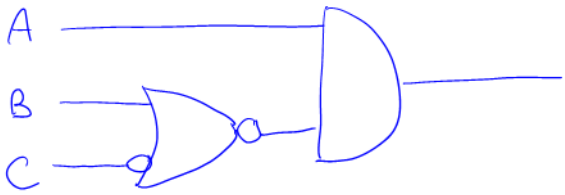
Total = $\frac{\quad}{25}$

- **All of the work on this test must be your own.**
- You may use a scientific calculator. You may not use a calculator with graphing capability or a smartphone app.

GOOD LUCK!

1. (3 points) Draw the gate diagram for the following Boolean expression.

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



(1) correct and/or gates
(1) correct negations
(1) correct order of ops

2. (4 points) Is the expression $\sim p \oplus (\sim p \wedge q)$ logically equivalent to $\sim (p \vee q)$? Justify your answer using a truth table.

p	q	$\sim p$	$\sim p \wedge q$	$\sim p \oplus (\sim p \wedge q)$	$p \vee q$	$\sim (p \vee q)$
0	0	1	0	1	0	1
0	1	1	1	0	1	0
1	0	0	0	0	1	0
1	1	0	0	0	1	0

yes

3. (2 points) The following statement is true: "If you wear a bowtie, then you will be fashionable." Given that, is it possible for each of the following statements to be true? Select the correct choice.

   (a) You wear a bowtie and you are fashionable. Yes / No

   (b) You wear a bowtie and you are not fashionable. Yes / No

   (c) You are not wearing a bowtie and you are fashionable. Yes / No

   (d) You are not wearing a bowtie and you are not fashionable. Yes / No

for $p \to q$, cannot have first one (p) true and second one (q) false

4. (2 points) Consider the following statement: "This muffin is made with raisins or walnuts." Are the following logically equivalent to this statement? Select the correct answer.

   (a) This muffin is made with walnuts or raisins. Yes / No

   (b) This muffin is made with raisins or it is made with walnuts and raisins. Yes / No

   (c) It is not true that this muffin is not made with raisins and not made with walnuts. Yes / No

   (d) If this muffin is not made with raisins, then it is made with walnuts. Yes / No

a) $w \vee r \iff r \vee w$ commutative ✓

b) $r \vee (r \wedge w) \iff r$ absorption ✗

c) $\sim(\sim r \wedge \sim w) \iff r \vee w$ De Morgan's ✓

a) $\sim r \Rightarrow w \iff r \vee w$ "or form" of conditional ✓

biconditional

5. (4 points) Consider the following: "If and only if it is brillig, then the toves will be slithy." Assuming this is true, answer the following questions.

   Note: to answer this question, you do not need to know what any of the words "brillig", "toves", or "slithy" mean.

   (a) It is brillig. Are the toves slithy? Yes / No / Maybe

   (b) The toves are slithy. Is it brillig? Yes / No / Maybe

   (c) The toves are not slithy. Is it brillig? Yes / No / Maybe

   (d) It is not brillig. Are the toves slithy? Yes / No / Maybe

for $p \Leftrightarrow q$, must have both true or both false

6. (4 points) Simplify the logical expression $(\sim p \vee q) \rightarrow (p \wedge q)$. Use a truth table to justify your answer.

p	q	$\sim p$	$\sim p \vee q$	$p \wedge q$	$(\sim p \vee q) \rightarrow (p \wedge q)$
0	0	1	1	0	0
0	1	1	1	0	0
1	0	0	0	0	1
1	1	0	1	1	1

p

For the questions on this page: if you are using the Laws of Logic, remember to use one law of logic per line, and be sure to state the name of the law you are using!

7. (4 points) Simplify the following using the laws of logic. If you're stuck, try using a truth table for part marks.

$$(\sim p \wedge (q \vee 0)) \vee (\sim p \wedge (\sim q \vee \sim q))$$

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

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

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

$\sim p \wedge 1$ complement

$\sim p$ identity

8. (2 points) Simplify the following. This is the nasty question I promised you and credit will only be awarded if the laws of logic are used to simplify the expression.

$$\overline{\overline{B}\,\overline{C} + \overline{C}}\left(\overline{AB} + \overline{\overline{C} + \overline{B}\,\overline{C}}\right)$$

$\overline{\overline{C}}\ (\overline{AB} + \overline{\overline{C}})$ absorption

$\overline{\overline{C}}$ absorption

C complement