## Midterm Exam I (October 01, 2020, 01:15 pm - 02:35 pm)

CSE 215: Foundations of Computer Science
State University of New York at Stony Brook, Fall 2020
Instructor: Prof. Pramod Ganapathi

Total points $=45$. Total questions $=9$. Total pages $=2$.
Instructions:

- Please write your full name and SBU student ID on the answer sheet.
- Please include the following integrity statement on your answer sheet:
"Academic integrity is expected of all students at all times, whether in the presence or absence of members of the faculty. Understanding this, I declare that I shall not give, use, or receive unauthorized aid in this examination. I have been warned that any suspected instance of academic dishonesty will be reported to the appropriate office and that I will be subjected to the maximum possible penalty permitted under University guidelines."


## Problem 1. [5 points]

Construct a truth table for the following statement form: $(r \wedge \sim p) \leftrightarrow(p \oplus q)$.

## Problem 2. [5 points]

Check the logical equivalence of $(p \rightarrow r) \vee(q \rightarrow r)$ and $(p \wedge q) \rightarrow r$.

## Problem 3. [5 points]

What truth values should be substituted for $p, q$, and $r$ to make the expression true:
$(\sim p \vee \sim q \vee \sim r) \equiv(p \vee q \vee r)$

## Problem 4. [5 points]

Find negations of the following statements.
(a) [3 points] Which of the following is a negation for "All dogs are loyal"? More than one answer may be correct.

1. All dogs are loyal.
2. No dogs are loyal.
3. Some dogs are disloyal.
4. Some dogs are loyal.
5. There is a disloyal animal that is not a dog.
6. There is a dog that is disloyal.
7. No animals that are not dogs are loyal.
8. Some animals that are not dogs are loyal.
(b) [1 point] $\forall$ integers $a, b$ and $c$, if $a-b$ is even and $b-c$ is even, then $a-c$ is even.
(c) [1 point] If the square of an integer is odd, then the integer is odd.

## Problem 5. [5 points]

Use the facts that the negation of a $\forall$ statement is a $\exists$ statement and that the negation of an if-then statement is an and statement to rewrite each of the statements without using the word necessary or sufficient.
(a) [3 points] Having a large income is not a necessary condition for a person to be happy.
(b) [2 points] Having a large income is not a sufficient condition for a person to be happy.

## Problem 6. [5 points]

Prove that the product of any two consecutive integers is even.

## Problem 7. [5 points]

Determine which statements are true and which are false. Prove those that are true and disprove those that are false.
(a) [2 points] If $r$ is any rational number and $s$ is any irrational number, then $r / s$ is irrational.
(b) [2 points] The sum of any two positive irrational numbers is irrational.
(c) [1 point] The square root of any rational number is irrational.

## Problem 8. [5 points]

Prove that for all integers $a$, if $a^{4}$ is even, then $a$ is even.

## Problem 9. [5 points]

A set of premises and a conclusion are given. Use the valid arguments forms to deduce the conclusion from the premises, giving a reason for each step. Assume all variables are statement variables.

1. $d \rightarrow c$
2. $e \rightarrow \sim a$
3. $f \vee e$
4. $\sim a \rightarrow \sim c \wedge b$
5. $\sim f$
6. $\therefore \sim d$
