PRINT Last name:_____   First name:_____

Signature:_____   Student ID:_____

Instructions: Show work for full credit. No notes, calculators, hats, cell phones, or aids of any kind. 15-minute time limit. By signing your name you agree that all work is your own.
Clearly circle or otherwise indicate **your answer in order to get credit.**
Questions 1-5 are 1pt each with no partial credit.
Questions 6-7 are 2pts each, and all work must be shown.

1. Which of the following propositions is correct?

   (a) The inverse of the implication $p \to q$ is logically equivalent to $p \to q$.

   (b) The converse of the implication $p \to q$ is logically equivalent to the inverse of $p \to q$.

   (c) The contrapositive of the implication $p \to q$ is logically equivalent to the inverse of $p \to q$.

   (d) The converse of the implication $p \to q$ is logically equivalent to the contrapositive of $p \to q$.

2. If x, y, and z are real numbers, $x < y < z$ means that x is less than y and y is less than z. Which of the following is the negation of $x < y < z$?

   (a) $x \geq y \geq z$

   (b) $x \geq y$ or $y \geq z$

   (c) $x > z$

   (d) $x > y > z$

3. Which of the following is the negation of the statement "I drive to work if and only if it is rainy?"

   (a) If I drive to work, then it is not rainy.

   (b) I drive to work if it is not rainy.

   (c) I drive to work if and only if it is not rainy.

   (d) I do not drive to work if and only if it is not rainy.

   (e) I do not drive to work if it is not rainy.

4. Suppose r and w are the propositions

   r: "it is rainy"
   w: "it is windy"

   Express in English a compound proposition that is logically equivalent to $w \to \neg r$.

   (a) If it is rainy, then it is not windy.

   (b) It is windy, but not rainy.

   (c) Whenever it is not windy, it is rainy.

   (d) Being windy is sufficient for it to be rainy.

5. Suppose m and a represent the propositions:

> m: "you are a member of the committee"
> a: "you attend the meeting."

Express in symbols the compound proposition

> "To be a member of the committee it is necessary that you attend the meeting."

(a) $\neg m \to a$

(b) $a \to \neg m$

(c) $m \to a$

(d) $a \to m$

6. Circle or otherwise indicate the rows of the truth table for which the following compound proposition is *true*:

$$(p \leftrightarrow \neg q) \oplus (q \wedge r)$$

p	q	r	
T	T	T	
T	T	F	
T	F	T	
T	F	F	
F	T	T	
F	T	F	
F	F	T	
F	F	F	

7. Use the truth table to prove the following logical equivalence:

$$(p \rightarrow q) \vee (p \rightarrow r) \equiv p \rightarrow (q \vee r)$$

(This logical equivalence might be helpful in identifying an alternative strategy for a direct proof.)

p	q	r	
T	T	T	
T	T	F	
T	F	T	
T	F	F	
F	T	T	
F	T	F	
F	F	T	
F	F	F	

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2. Which of the following is the negation of the statement "I drive to work if and only if it is rainy?"

   (a) I drive to work if it is not rainy.

   (b) I do not drive to work if it is not rainy.

   (c) I do not drive to work if and only if it is not rainy.

   (d) If I drive to work, then it is not rainy.

   (e) I drive to work if and only if it is not rainy.

3. If x, y, and z are real numbers, $x < y < z$ means that x is less than y and y is less than z. Which of the following is the negation of $x < y < z$?

   (a) $x > y > z$

   (b) $x \geq y \geq z$

   (c) $x > z$

   (d) $x \geq y$ or $y \geq z$

4. Suppose m and a represent the propositions:

   m: "you are a member of the committee"
   a: "you attend the meeting."

   Express in symbols the compound proposition

   "To be a member of the committee it is necessary that you attend the meeting."

   (a) $\neg m \to a$

   (b) $m \to a$

   (c) $a \to \neg m$

   (d) $a \to m$

5. Which of the following propositions is correct?

    (a) The converse of the implication $p \to q$ is logically equivalent to the inverse of $p \to q$.

    (b) The converse of the implication $p \to q$ is logically equivalent to the contrapositive of $p \to q$.

    (c) The inverse of the implication $p \to q$ is logically equivalent to $p \to q$.

    (d) The contrapositive of the implication $p \to q$ is logically equivalent to the inverse of $p \to q$.

6. Circle or otherwise indicate the rows of the truth table for which the following compound proposition is *false*:

$$(p \vee \neg q) \oplus (q \leftrightarrow r)$$

p	q	r	
T	T	T	
T	T	F	
T	F	T	
T	F	F	
F	T	T	
F	T	F	
F	F	T	
F	F	F	

7. Use the truth table to prove the following logical equivalence:

$$(p \to r) \land (q \to r) \equiv (p \lor q) \to r$$

(This logical equivalence might be helpful in identifying an alternative strategy for a direct proof.)

p	q	r	
T	T	T	
T	T	F	
T	F	T	
T	F	F	
F	T	T	
F	T	F	
F	F	T	
F	F	F	