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| **MATH 381-003**<br>**September 28, 2023** | **Exam 1** | **Time Limit: 75 minutes**<br>**Instructor: Reese Lance** |

**Print your first and last name neatly in the box below, and print your ONYEN neatly in the box at the bottom.**

**Name:**

**Read the following directions carefully:**

- You have 75 minutes to complete this exam. Manage your time carefully.
- This is a closed-book, closed-note, individual exam. No outside help is allowed (e.g. no book, no notes, no internet, no discussing/communicating with others, except the instructor). Cell phones, laptops, and other technological devices are not allowed.
- Responses that do not include work/justification will not receive full credit, unless indicated otherwise in the problem statement.
- Illegible answers will not receive any credit. Work must be presented clearly, with all variables defined before use, and with correct mathematical notation to receive credit. You should write in complete sentences.
- Only work written on the exam sheet in the designated space for each question will be graded. You may use the backs of the pages as scratch paper, but make sure your complete answer (including any required justification) is copied onto the front of the exam sheet, as the backs will not be viewed for grading. You are not allowed to use your own scratch paper that you brought to class, but you may get additional scratch paper from the instructor, if you need it. (Be careful not to fill up the designated answer space before you settle on your final answer to the question.)
- On problems with multiple parts, clearly separate and label each part. If you have extraneous stratch work in the designated answer space, make sure to mark out anything you don't want graded and clearly mark/indicate your final answer along with any required justification.

Honor Pledge:

I have read and understood the directions on the previous page, and I certify that I have neither given nor received any unauthorized assistance on this exam. Further, I pledge that my conduct on this exam is in full compliance with UNC's Honor Code.

**Signature:**

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**ONYEN:**

You may use any of the following logical equivalences on this exam. Please avoid using any logical equivalence that is NOT listed below.

| **Name** | **Equivalence** |
|---|---|
| Identity Laws | $p \wedge \mathbf{T} \equiv p$<br>$p \vee \mathbf{F} \equiv p$ |
| Domination Laws | $p \vee \mathbf{T} \equiv \mathbf{T}$<br>$p \wedge \mathbf{F} \equiv \mathbf{F}$ |
| Idempotent Laws | $p \vee p \equiv p$<br>$p \wedge p \equiv p$ |
| Double Negation Law | $\neg(\neg p) \equiv p$ |
| Commutative Laws | $p \vee q \equiv q \vee p$<br>$p \wedge q \equiv q \wedge p$ |
| Associative Laws | $(p \vee q) \vee r \equiv p \vee (q \vee r)$<br>$(p \wedge q) \wedge r \equiv p \wedge (q \wedge r)$ |
| Distributive Laws | $p \vee (q \wedge r) \equiv (p \vee q) \wedge (p \vee r)$<br>$p \wedge (q \vee r) \equiv (p \wedge q) \vee (p \wedge r)$ |
| De Morgan's Laws | $\neg(p \vee q) \equiv \neg p \wedge \neg q$<br>$\neg(p \wedge q) \equiv \neg p \vee \neg q$ |
| Absorption Laws | $p \vee (p \wedge q) \equiv p$<br>$p \wedge (p \vee q) \equiv p$ |
| Negation Laws | $p \vee \neg p \equiv \mathbf{T}$<br>$p \wedge \neg p \equiv \mathbf{F}$ |
| Conditional Disjunction Equivalence | $p \to q \equiv \neg p \vee q$ |
| Contrapositive | $p \to q \equiv \neg q \to \neg p$ |
| Biconditional Equivalence | $p \leftrightarrow q \equiv (p \to q) \wedge (q \to p)$ |
| De Morgan's Laws for Quantifiers | $\neg\exists x P(x) \equiv \forall x \neg P(x)$<br>$\neg\forall x P(x) \equiv \exists x \neg P(x)$ |