



Finite MATH

Statements of Logic

Probability, Combinatorics, Matrices, Linear Programming & More

Statements

A sentence that is either true or false. A statement cannot be both true and false.

EX: A right angle measures 90° is a true statement.

Parallel lines intersect is a false statement.

Truth Tables & Logical Connectives

A truth value is the attribute assigned to a statement in respect to its truth or falsehood.

A truth table is a table showing all the possible combinations of statements in symbolic logic and their truth values.

A logical connective is a symbol or word used to connect two or more statements.

Negation of a Statement

The statement "not p ," written as $\neg p$, p and $\neg p$ have opposite truth values.

Make a truth table for the negation of statement p .

p	$\neg p$
T	F
F	T

Conjunction of a Statement

The statement " p and q ," written as $p \wedge q$. The truth value of a conjunction is true only when both p and q are true. If either p or q is false, or if both p and q are false, the conjunction is false.

Make a truth table for the statement p and q .

p	q	$p \wedge q$
T	T	T
T	F	F
F	T	F
F	F	F

Disjunction of a Statement

The statement " p or q ," written as $p \vee q$. The truth value of a disjunction is true when p or q is true or when both p and q are true. If both p and q are false, then the disjunction is false.

Make a truth table for the statement p or q .

p	q	$p \vee q$
T	T	T
T	F	T
F	T	T
F	F	F

You can use logical connectives to represent statements.

EX: Let p represent the statement "It is Friday." Let q represent the statement "It is sunny." Represent each statement symbolically.

Statement	Symbols
It is not Friday.	$\neg p$
It is Friday and it is sunny.	$p \wedge q$
It is Friday, but it is not sunny.	$p \wedge \neg q$ OR $p \wedge (\neg q)$
It is Friday or it is sunny.	$p \vee q$
It is not Friday and it is not sunny.	$\neg p \wedge \neg q$ OR $(\neg p) \wedge (\neg q)$

Compound Statements

A statement that uses two or more logical connectives.

They have a truth value that is determined by the truth values of the simple statements that comprise them.

For compound statements that contain a negation and another logical connective, the negation is performed first.

Construct a truth table for the compound statement $\neg p \wedge (q \vee m)$.

p	q	m	$\neg p$	$(q \vee m)$	$\neg p \wedge (q \vee m)$
T	T	T	F	T	F
T	T	F	F	T	F
T	F	T	F	T	F
T	F	F	F	F	F
F	T	T	T	T	T
F	T	F	T	T	T
F	F	T	T	T	T
F	F	F	T	F	F

Logically Equivalent Statements & De Morgan's Laws

Two statements are logically equivalent if, and only if, they have identical truth values. The symbol \equiv is used to represent logically equivalent statements.

For compound statements p and q , compare the truth values of the truth tables. If the truth values in each row are the same, the statements are logically equivalent. If the truth values in any row are not the same, the statements are not logically equivalent.

De Morgan's Laws

Used to determine the negation of a conjunction and the negation of a disjunction.

One principle is that the negation of p and q is equivalent to not p or not q . In other words, the negation of a conjunction is logically equivalent to a disjunction in which each component is negated. So, $\neg(p \wedge q) \equiv \neg p \vee \neg q$.

EX: Use De Morgan's Laws to find the negation of the statement, *Dennis is a girl and plays baseball.*

The negation of this statement is *Dennis is not a girl or does not play baseball.*

Another principle is that the negation of p or q is equivalent to not p and not q . In other words, the negation of a disjunction is logically equivalent to a conjunction in which each component is negated. So, $\neg(p \vee q) \equiv \neg p \wedge \neg q$.

EX: Use De Morgan's Laws to find the negation of the statement, *Daniel was at play rehearsal on Tuesday or he practiced his music.*

The negation of this statement is *Daniel was not at play rehearsal on Tuesday and he did not practice his music.*

As with other compound statements, a truth table can be used to demonstrate the logical equivalence of De Morgan's Laws.

Use De Morgan's Laws to construct a truth table to show that $\neg(p \wedge q) \equiv \neg p \vee \neg q$.

p	q	$\neg p$	$\neg q$	$(p \wedge q)$	$\neg(p \wedge q)$	$\neg p \vee \neg q$
T	T	F	F	T	F	F
T	F	F	T	F	T	T
F	T	T	F	F	T	T
F	F	T	T	F	T	T

Because the truth values in each row for $\neg(p \wedge q)$ are the same as the truth values in each row for $\neg p \vee \neg q$, then $\neg(p \wedge q) \equiv \neg p \vee \neg q$.

Conditional Statements (a Conditional)

An if-then statement in the form "If p , then q ," where p is the hypothesis and q is the conclusion. The hypothesis is the statement following "If," and the conclusion is the statement following "then."

A conditional is symbolized by $p \rightarrow q$ and reads " p implies q ."

A conditional statement is false when, and only when, the hypothesis p is true and the conclusion q is false. Otherwise, the conditional is true.

EX: Identify the hypothesis and conclusion of the conditional "If two lines intersect at right angles, then the lines are perpendicular."

The hypothesis is the statement following "if" or "Two lines intersect at right angles."

The conclusion is the statement following "then" or "The lines are perpendicular."

EX: Write a conditional of the statement "All farmers are government employees."

If a person is a farmer, then the person is a government employee.

Construct a truth table for the conditional "If p , then q ."

p	q	$p \rightarrow q$
T	T	T
T	F	F
F	T	T
F	F	T

Truth tables can be used to analyze compound conditional statements.

Construct a truth table for the conditional statement $(p \wedge \neg q) \rightarrow \neg q$.

p	q	$\neg q$	$(p \wedge \neg q)$	$(p \wedge \neg q) \rightarrow \neg q$
T	T	F	F	F
T	F	T	T	T
F	T	F	F	F
F	F	T	F	F

Negation of a Conditional Statement

"If p , then q " is logically equivalent to " p and not q ." So, $\neg(p \rightarrow q) \equiv p \wedge \neg q$.

EX: Write the negation of the conditional statement "If Greg is in the band, then he plays the saxophone."

Greg is in the band, and he does not play the saxophone.

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Finite Math Selected Solutions Guide

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Table of Contents Finite Math Selected Solutions Guide

1. Understanding the eBook Finite Math Selected Solutions Guide
 - The Rise of Digital Reading Finite Math Selected Solutions Guide
 - Advantages of eBooks Over Traditional Books
2. Identifying Finite Math Selected Solutions Guide
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Finite Math Selected Solutions Guide
 - User-Friendly Interface
4. Exploring eBook Recommendations from Finite Math Selected Solutions Guide

- Personalized Recommendations
- Finite Math Selected Solutions Guide User Reviews and Ratings
- Finite Math Selected Solutions Guide and Bestseller Lists
- 5. Accessing Finite Math Selected Solutions Guide Free and Paid eBooks
 - Finite Math Selected Solutions Guide Public Domain eBooks
 - Finite Math Selected Solutions Guide eBook Subscription Services
 - Finite Math Selected Solutions Guide Budget-Friendly Options
- 6. Navigating Finite Math Selected Solutions Guide eBook Formats
 - ePub, PDF, MOBI, and More
 - Finite Math Selected Solutions Guide Compatibility with Devices
 - Finite Math Selected Solutions Guide Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Finite Math Selected Solutions Guide
 - Highlighting and Note-Taking Finite Math Selected Solutions Guide
 - Interactive Elements Finite Math Selected Solutions Guide
- 8. Staying Engaged with Finite Math Selected Solutions Guide
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Finite Math Selected Solutions Guide
- 9. Balancing eBooks and Physical Books Finite Math Selected Solutions Guide
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Finite Math Selected Solutions Guide
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Finite Math Selected Solutions Guide
 - Setting Reading Goals Finite Math Selected Solutions Guide
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Finite Math Selected Solutions Guide

- Fact-Checking eBook Content of Finite Math Selected Solutions Guide
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning
- Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
14. Embracing eBook Trends
- Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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