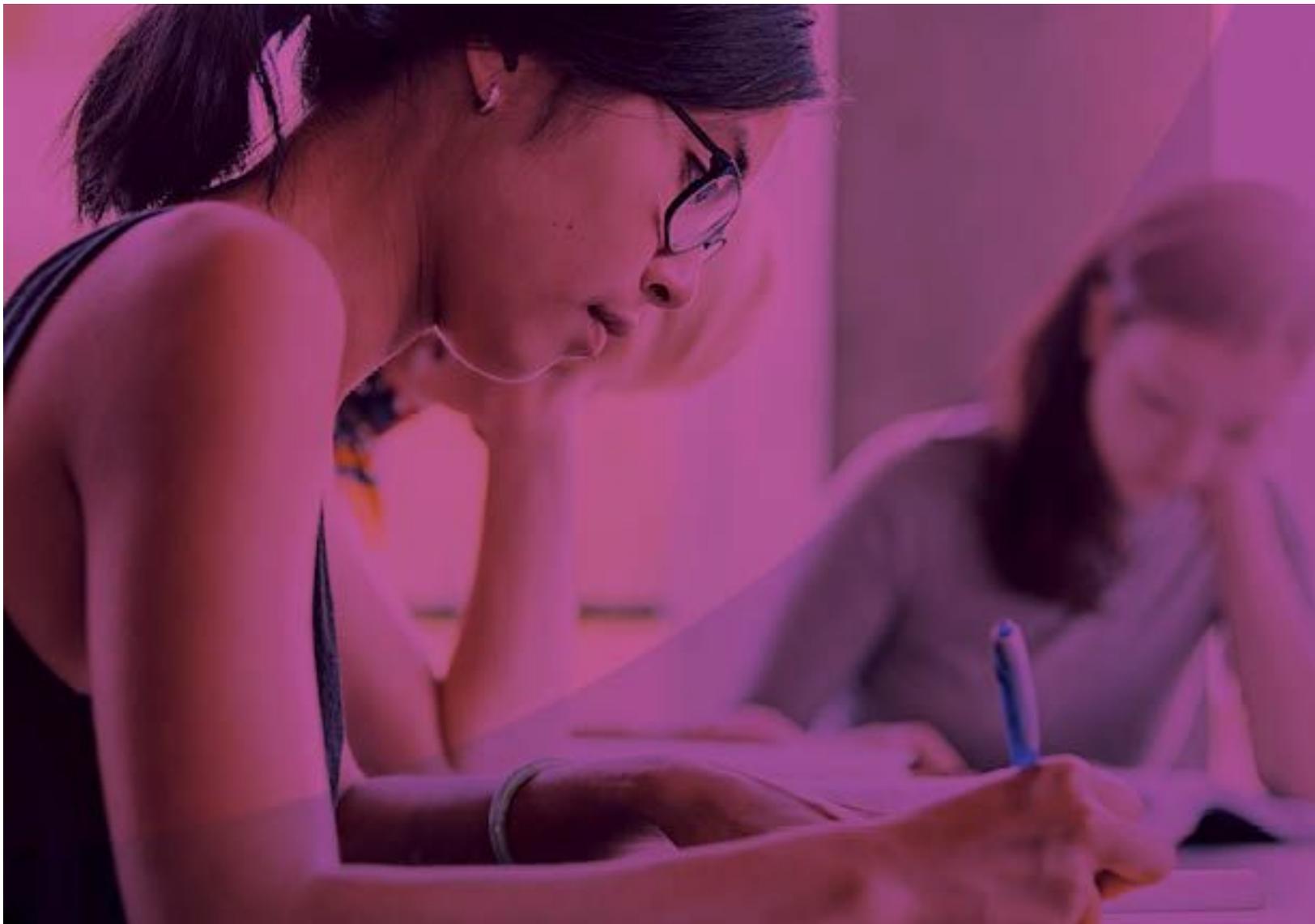




# College Algebra

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Alta College Algebra was developed to meet the scope and sequence of a typical one semester college algebra course. To develop the course, Knewton used three main sources of content: Openstax, videos created by a Math Professor we have partnered with, and a team of Subject Matter Experts (SMEs). The SMEs come from diverse backgrounds and are all accomplished academics in the field of Mathematics.

Alta College Algebra has two instructional sequences for every learning objective, giving students multiple opportunities to learn new concepts. Between our OpenStax text content, instructional videos, and Knewton SMEs, we were able to solicit ideas from math instructors and students. Alta College Algebra covers the typical breadth of college algebra topics and also provides the necessary depth to ensure the course is manageable and engaging for instructors and students alike.

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## College Algebra | Table of Contents

### Chapter 1: Prerequisites

#### 1.1 Algebra Essentials

- Sets and Venn Diagrams
  - Represent a set using a written description and the roster method
  - Identify subsets, universal sets, and empty sets
  - Illustrate two sets using a Venn diagram and set notation
- Set Operations
  - Determine the complement of a set using Venn diagrams or set notation
  - Determine the intersection of two sets using Venn diagrams or set notation
  - Determine the union of two sets using Venn diagrams or set notation
  - Perform operations on sets
- Properties of Real Numbers and Order of Operations
  - Distinguish between natural numbers, whole numbers, and integers
  - Distinguish between rational and irrational numbers
  - Perform calculations using order of operations
  - Use the inverse and identity properties of real numbers
  - Use the commutative, associative, and distributive properties of real numbers
- Evaluate and Simplify Algebraic Expressions
  - Evaluate algebraic expressions with a single variable
  - Evaluate algebraic expressions with two variables
  - Identify constants and variables
  - Use a formula
  - Simplify algebraic expressions
- Evaluate and Simplify Absolute Value Expressions
  - Understand absolute value and evaluate absolute value expressions with the order of operations
  - Evaluate algebraic expressions involving absolute value

#### 1.2 Exponents and Scientific Notation

- Product, Quotient, and Power Properties of Exponents
  - Understand exponent notation
  - Use the product rule of exponents
  - Use the quotient rule of exponents
  - Use the power rule of exponents
- Negative Exponents and Simplifying Exponential Expressions
  - Use the negative and zero exponent rule
  - Find the power of a product
  - Find the power of a quotient
  - Simplify exponential expressions
- Scientific Notation
  - Convert between standard and scientific notation
  - Multiply and divide numbers in scientific notation

#### 1.3 Radicals and Rational Exponents

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- Simplify Radicals
  - Evaluate square roots
  - Use the product rule to simplify square roots
  - Use the quotient rule to simplify square roots
- Operations with Radicals
  - Add and subtract square roots
  - Rationalize denominators with a monomial denominator
  - Rationalize denominators using the conjugate
- Rational Exponents and Higher Order Radicals
  - Simplify  $n$ th roots
  - Operations with  $n$ th roots
  - Switch between radical and rational exponent form
  - Evaluate expressions with rational exponents

#### 1.4 Polynomials

- Properties of Polynomials
  - Identify the degree and leading coefficient of a polynomial
  - Identify monomials, binomials, and trinomials
- Operations on Polynomials
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  - Multiply binomials together
  - Multiply polynomials together
  - Perform operations with polynomials of several variables

#### 1.5 Factoring Polynomials

- Factor Quadratics
  - Factor the greatest common factor of a polynomial
  - Factor a trinomial
  - Factor a trinomial by grouping
- Factor Quadratics with Special Products
  - Factor a perfect square trinomial
  - Factor a difference of squares
- Factor Cubics
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  - Factor the sum and difference of cubes
- Factor Expressions with Fractional or Negative Exponents
  - Factor expressions using fractional or negative exponents
  - Factor expressions using greatest common factor and other technique

#### 1.6 Rational Expressions

- Multiply and Divide Rational Expressions
    - Simplify rational expressions
    - Multiply rational expressions
    - Divide rational expressions
  - Add and Subtract Rational Expressions and Simplify Complex Rational Expressions
    - Add and subtract rational expressions
-

- Simplify complex rational expressions

## Chapter 2: Equations and Inequalities

### 2.1 The Rectangular Coordinate Systems and Graphs

- Cartesian Coordinates and Distances
  - Plot ordered pairs in a Cartesian coordinate system
  - Graph equations by plotting points
  - Use the distance formula, given two points
  - Use the midpoint formula

### 2.2 Linear and Rational Equations in One Variable

- Solve Linear Equations in One Variable
  - Identify identity, conditional, and inconsistent equations
  - Solve equations in one variable algebraically, variable just on one side
  - Solve equations in one variable algebraically, variable on both sides
- Solve Rational Equations
  - Solve a rational equation, monomials in denominator
  - Solve a rational equation, binomials in denominator
  - Solve a rational equation, requires factoring to find least common denominator
- Identify Slopes and Intercepts
  - Find the slope of a line given two points
  - Understand the relationship between the slope and y-intercept of a line and its equation
  - Find x -intercepts and y -intercepts
- Find Linear Equations
  - Find equation of a line, in slope-intercept form, given slope and one point (point-slope formula)
  - Find equation, in slope-intercept form, of a line passing through two given points
  - Given slope and intercept, find the equation of a line and write it in standard form
  - Find the equation of vertical and horizontal lines
- Parallel and Perpendicular Lines
  - Given the equations of two lines, determine whether their graphs are parallel or perpendicular
  - Write the equation of a line parallel to a given line
  - Write the equation of a line perpendicular to a given line

### 2.3 Models and Applications

- Word Problems with Linear Equations
    - Set up a linear equation to solve a real-world application
    - Translate verbal expressions into mathematical expressions
    - Use a formula to solve a real-world application
  - Problem Solving
    - Solve simple interest applications
    - Solve a formula for a specified variable
    - Use a formula to solve a geometric application
-

- Use the Pythagorean theorem

## 2.4 Complex Numbers

- Basics of Complex Numbers
  - Express the square root of a negative number as a multiple of  $i$
  - Simplify powers of  $i$
- Operations on Complex Numbers
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  - Multiply two complex numbers
  - Divide two complex numbers

## 2.5 Quadratic Equations

- Solve Quadratic Equations by Factoring
  - Solve quadratic equations by factoring, leading coefficient 1
  - Solve quadratic equations by factoring, leading coefficient  $> 1$
- Complete the Square
  - Solve quadratic equations by the square root property
  - Solve quadratic equations by completing the square
- Quadratic Formula
  - Use the discriminant to classify the solutions of a quadratic equation
  - Solve quadratic equations by using the quadratic formula

## 2.6 Other Types of Equations

- Solve Higher Order Equations with Factoring
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  - Solve equations by factoring with grouping
- Solve Equations Quadratic in Form by Factoring
  - Solve fourth-degree equation in quadratic form
  - Solve quadratic with binomial
- Solve Radical Equations
  - Solve radical equations with a single radical
  - Solve radical equations with two radicals
- Solve Other Types of Equations
  - Solve equations using reciprocal exponents
  - Solve equations involving rational exponents by factoring out the greatest common factor
  - Solve rational equation which leads to a quadratic

## 2.7 Linear Inequalities and Absolute Value Inequalities

- Interval Notation and Inequalities
    - Use interval notation
    - Use properties of inequalities
    - Solve simple inequalities in one variable algebraically
    - Solve compound inequalities in one variable algebraically
  - Absolute Value Equations and Inequalities
-

- Solve absolute value equations
- Solve absolute value inequalities
- Applications with Linear Inequalities
  - Translate words to an inequality and solve applications with linear inequalities
  - Solve applications with compound inequalities
  - Solve applications with absolute value

## 2.8 Inequalities Requiring Factoring

- Rational and Quadratic Inequalities
  - Solve quadratic inequalities in one variable, graph the solution set, and express the solution set using interval notation
  - Solve inequalities that involve rational expressions, graph the solution sets, and express the solution set using interval notation

## Chapter 3: Functions

### 3.1 Functions and Function Notation

- Relations and Functions
  - Identify domain and range from a set of ordered pairs
  - Determine whether a relation represents a function
  - Use the vertical line test to identify functions
- One-to-One Functions
  - Determine whether a function is one-to-one
  - Use the horizontal line test to identify one-to-one functions
- Function Notation
  - Evaluate a function using function notation
  - Solve a function using function notation
  - Evaluate or solve a function from a table
  - Evaluate or solve a function from a graph

### 3.2 Absolute Value Functions and Other Toolkit Functions

- Graph Absolute Value Functions
  - Graph an absolute value function
- Toolkit Functions
  - Identify graphs of toolkit functions

### 3.3 Domain and Range

- Domain and Range of Functions
  - Find the domain of a function defined by an equation
  - Find the domain and range of a function defined by a graph
- Piecewise Functions
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  - Evaluate piecewise-defined functions

### 3.4 Rates of Change and Behavior of Graphs

- Graphical Properties of Functions
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    - Use a graph to determine intervals of increase and decrease and local extrema
    - Use a graph to locate the absolute maximum and absolute minimum
-

- Difference Quotients
  - Determine the difference quotient

### 3.5 Composition of Functions

- Combinations of Functions
  - Combine functions using algebraic operations
  - Create a new function by composition of functions
- Evaluate Composite Functions
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  - Evaluate composite functions given the graph of functions
  - Evaluate composite functions given explicit functions
- Properties of Composite Functions
  - Find the domain of a composite function
  - Decompose a composite function into its component functions

### 3.6 Function Graphs and Transformations

- Transformations of Functions
  - Graph functions using vertical and horizontal shifts
  - Graph functions using reflections about the x-axis and the y-axis
  - Graph functions using compressions and stretches
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  - Determine whether a function is even, odd, or neither from its graph
  - Determine whether a function is even, odd, or neither given algebraically

### 3.7 Inverse Functions

- Inverse Function Values
  - Verify inverse function ordered pairs
  - Given graph of a function, find value of inverse function
  - Given table of values of a function, find value of inverse function
- Find Inverse Functions
  - Verify inverse function pairs algebraically
  - Determine the domain and range of an inverse function, and restrict the domain of a function to make it one-to-one
  - Given function, find the inverse function
  - Use the graph of a one-to-one function to graph its inverse function on the same axes

### 3.8 Circles

- Graphs of Circles
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  - Determine the center and radius of a circle from the standard equation of a circle and sketch its graph

## Chapter 4: Linear Functions and Modeling

### 4.1 Linear Functions

- Interpretations of Linear Functions
    - Represent a linear function in table form
-

- Determine whether a linear function is increasing, decreasing, or constant
- Interpret slope as a rate of change
- Represent a real-world application as a linear function
- Graph linear functions

#### 4.2 Modeling with Linear Functions

- Application of Linear Functions
  - Build linear models from verbal descriptions, given a y-intercept
  - Build linear models from verbal descriptions, given inputs and outputs
  - Use a diagram to build a model
  - Model a set of data with a linear function

#### 4.3 Fitting Linear Models to Data

- Scatter Diagrams and Lines of Best Fit
  - Draw and interpret scatter diagrams
  - Distinguish between linear and nonlinear relations
- Linear Regressions
  - Find the line of best fit using a graphing utility
  - Use the line of best fit to make predictions

### Chapter 5: Polynomial and Rational Functions

#### 5.1 Quadratic Functions

- Characteristics of Parabolas
  - Determine axis of symmetry and vertex of parabolas from a graph
  - Determine x- and y-intercepts of parabolas from a graph
  - Find the direction a parabola opens and its axis of symmetry and vertex from the general form of its equation
  - Identify the axis of symmetry and vertex of a parabola from its equation in standard form
- Graphs of Quadratic Functions
  - Write the equation of a quadratic function given vertex and a point on a graph
  - Write the equation of a quadratic function given intercepts on a graph
  - Write the equation of a quadratic function in standard form given the equation in general form
- Applications of Quadratic Functions
  - Find the domain and range of a quadratic function
  - Determine the maximum and minimum values of quadratic functions
  - Find the x- and y-intercepts of a quadratic function
  - Use a quadratic function to model projectile motion
- Quadratic Regressions
  - Find the parabola of best fit using a graphing utility
  - Use the parabola of best fit to make predictions

#### 5.2 Graphs of Polynomial and Power Functions

- End Behavior of Polynomial Functions
    - Identify power functions and polynomial functions
    - Identify if a graph is a polynomial function
    - Determine end behavior
-

- Local Behavior of Polynomial Functions
  - Identify intercepts of polynomial functions in factored form
  - Understand the relationship between degree, turning points, and x-intercepts
  - Understand the intermediate value theorem
  - Use factoring to find zeros of polynomial functions
  - Identify zeros and their multiplicities from an equation or a graph
- Write and Graph Polynomial Functions
  - Draw conclusions about a polynomial function from a graph
  - Graph polynomial functions
  - Write a formula for a polynomial function from a graph
  - Determine equation of a polynomial given key information

### 5.3 Dividing Polynomials

- Long Division of Polynomials
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  - Use polynomial division to solve application problems
- Synthetic Division and Remainder Theorem
  - Use synthetic division to divide polynomials
  - Evaluate a polynomial using the remainder theorem

### 5.4 Zeros of Polynomial Functions

- Rational Zeros of Polynomial Functions
  - Use the factor theorem to solve a polynomial equation
  - Use the rational zero theorem to find rational zeros
  - Solve real-world applications of polynomial equations
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  - Find zeros of polynomial functions with complex zeros
  - Use the linear factorization theorem to find polynomials with given zeros
  - Use Descartes' rule of signs

### 5.5 Rational Functions

- Asymptotic Behavior of Rational Functions
  - Use arrow notation to describe local behavior and end behavior of rational functions
  - Identify vertical asymptotes and removable discontinuities of rational functions
  - Identify horizontal and slant asymptotes of rational functions
- Graphs and Applications of Rational Functions
  - Solve applied problems involving rational functions
  - Find the intercepts of a rational function
  - Graph rational functions
  - Find the equation of a rational function from a graph

### 5.6 Inverses and Radical Functions

- Inverses of Polynomial Functions
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    - Restrict the domain to find the inverse of a polynomial function
    - Solve an application with the inverse of a function
  - Inverses of Radical and Rational Functions
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-

- Find the domain of a radical function composed with a rational function
- Find the inverse of a rational function

#### 5.7 Modeling Using Variation

- Direct and Inverse Variation
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  - Solve problems involving joint variation

### Chapter 6: Exponential and Logarithmic Functions

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  - Evaluate exponential functions
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  - Find the equation of an exponential function in a word problem context
  - Calculate compound interest
  - Evaluate exponential functions with base  $e$
  - Calculate continuous growth and decay

#### 6.2 Graphs of Exponential Functions

- Exponential Function Graphs
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  - Graph exponential functions using transformations
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  - Write an exponential function from a description

#### 6.3 Logarithmic Functions

- Relate Logarithms and Exponents
  - Convert from logarithmic to exponential form
  - Convert from exponential to logarithmic form
- Evaluate Logarithmic Expressions
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  - Evaluate logarithms with negative integer solutions
  - Use common logarithms
  - Use natural logarithms

#### 6.4 Graphs of Logarithmic Functions

- Logarithmic Function Graphs
  - Identify the domain of a logarithmic function
  - Graph logarithmic functions
  - Graph transformations of logarithmic functions
  - Write a logarithmic function from a description

#### 6.5 Logarithmic Properties

- Basic Properties of Logarithms
    - Understand the basic properties of logarithms
-

- Use the product rule for logarithms
- Use the quotient rule for logarithms
- Use the power rule for logarithms
- Rewrite Logarithmic Expressions Using Properties
  - Expand logarithmic expressions
  - Condense logarithmic expressions
  - Use the change-of-base formula for logarithms

#### 6.6 Exponential and Logarithmic Equations

- Solve Exponential Equations
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  - Rewrite equations so all powers have the same base and solve exponential equations
  - Use logarithms to solve exponential equations
  - Solve an equation with a base  $e$  using natural logarithms
- Solve Logarithmic Equations
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  - Use logarithm properties and the definition of the logarithm to solve logarithmic equations
  - Use the one-to-one property of logarithms to solve logarithmic equations

#### 6.7 Exponential and Logarithmic Models

- Applications of Exponential and Logarithmic Functions
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  - Applied logarithmic models
  - Choose an appropriate model for data
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#### 6.8 Fitting Exponential Models to Data

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  - Build a logarithmic model from data using a graphing utility
- Logistic Growth Models
  - Use logistic growth models
  - Build a logistic model from data using a graphing utility

### Chapter 7: Systems of Equations and Inequalities

#### 7.1 Systems of Linear Equations in Two Variables

- Graphing Systems of Linear Equations
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    - Solve systems of equations in two variables by graphing
  - Solving Systems of Linear Equations
    - Solve systems of equations in two variables by substitution
    - Solve systems of equations in two variables by addition
    - Identify inconsistent and dependent systems of equations containing two variables, and express the solution of dependent equations
  - Applications of Systems of Linear Equations
    - Use systems of equations to investigate profits
-

- Write and solve a system of equations in two variables from a word problem
- Linear Inequalities in Two Variables
  - Solve a linear inequality in two variables by graphing
  - Solve a linear system of inequalities by graphing

#### 7.2 Systems of Linear Equations in Three Variables

- Systems of Linear Equations in Three Variables
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  - Solve systems of three equations in three variables
  - Identify inconsistent and dependent systems of equations containing three variables, and express the solution of a system of dependent equations

#### 7.3 Systems of Nonlinear Equations in Two Variables

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  - Solve a system of nonlinear equations representing a circle and a line
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- Graphing Nonlinear Inequalities and Systems of Inequalities
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  - Graph a system of nonlinear inequalities

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  - Decompose a rational expression where the denominator has a nonrepeated irreducible quadratic factor
  - Decompose a rational expression where the denominator has a repeated irreducible quadratic factor

#### 7.5 Matrices and Matrix Operations

- Introduction to Matrices
  - Determine the order of a matrix and describe elements within a matrix
  - Add or subtract matrices
- Matrix Multiplication
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  - Find the sum or difference of scalar multiples
  - Multiply two matrices

#### 7.6 Augmented Matrices and Gaussian Elimination

- Solving Systems with Gaussian Eliminations
    - Convert between a system of equations and its corresponding augmented matrix
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    - Use row operations to solve a system of linear equations in three variables
    - Use matrices to solve applications of systems of linear equations
  - Solving Systems with Gauss-Jordan Elimination
    - Use Gauss-Jordan elimination to solve a system of linear equations
-

## 7.7 Determinants of Matrices and the Inverse Matrix

- Finding Determinants of Matrices
  - Find the determinant of a  $2 \times 2$  matrix
  - Find the determinant of a  $3 \times 3$  matrix
- Inverse and Identity Matrices
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  - Find the inverse of a  $3 \times 3$  matrix
- Solving Systems with Inverses
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  - Solve a system of linear equations using the inverse of a  $3 \times 3$  matrix

## 7.8 Cramer's Rule

- Solving Systems with Cramer's Rule
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## 7.9 Linear Programming

- Using Linear Programming
  - Graph a feasible region given a set of constraints
  - Find the maximum value of an objective function given constraints by graphing
  - Solve application problems using linear programming

## Chapter 8: Conic Sections

### 8.1 Ellipses

- Ellipses Centered at the Origin
  - Identify key points and axes of ellipses from a graph
  - Identify key points and axes of ellipses from an equation
  - Write the equation in standard form of an ellipse centered at the origin
  - Graph an ellipse centered at the origin from an equation in standard form
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  - Identify key points and axes of ellipses not centered at the origin
  - Write the equation in standard form of an ellipse not centered at the origin
  - Graph an ellipse not centered at the origin
- Ellipses Not in Standard Form and Applications of Ellipses
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  - Graph an ellipse where the equation is not given in standard form
  - Use ellipses in applications

### 8.2 Hyperbolas

- Hyperbolas Centered at the Origin
    - Locate the vertices and foci of a hyperbola from a graph
    - Identify vertices, foci, and asymptotes of a hyperbola from an equation
    - Write the equation of a hyperbola centered at the origin in standard form
-

- Graph a hyperbola centered at the origin from an equation in standard form
- Hyperbolas Not Centered at the Origin
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  - Write the equation of a hyperbola not centered at the origin
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  - Convert an equation of a hyperbola into standard form
  - Graph a hyperbola from an equation given in general form
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### 8.3 Parabolas

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  - Identify key components of a parabola not centered at the origin
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### 9.1 Sequences

- Introduction to Sequences
  - Write the terms of a sequence defined by an explicit formula
  - Write the terms of a sequence defined by a piecewise explicit formula
- Recursive Sequences
  - Write the terms of a sequence defined by a recursive formula
  - Write the terms of a sequence defined by a recursive formula with more than one initial term

### 9.2 Arithmetic Sequences

- Arithmetic Sequences
  - Find the common difference of an arithmetic sequence
  - Write terms of an arithmetic sequence
  - Write a recursive formula for an arithmetic sequence
  - Write an explicit formula for an arithmetic sequence
- Applications of Arithmetic Sequences
  - Find specific terms of an arithmetic sequence given other terms
  - Solve application problems with arithmetic sequences

### 9.3 Geometric Sequences

- Geometric Sequences
-

- Find the common ratio of a geometric sequence
- Write terms of a geometric sequence
- Write a recursive formula for a geometric sequence
- Write an explicit formula for a geometric sequence
- Applications of Geometric Sequences
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  - Solve application problems with geometric sequences
  - Solve geometric sequence problems

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- Summation Notation and Arithmetic Series
  - Evaluate expressions using summation notation
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  - Find the sum of a finite geometric series
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  - Solve application problems with geometric series
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  - Evaluate an expression with factorials
- Permutations
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  - Find the number of permutations of  $n$  distinct objects using a formula
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  - Find the number of combinations using the formula
  - Find the number of subsets of a set

#### 9.6 Binomial Theorem

- Binomial Expansion
  - Find a binomial coefficient
  - Expand a binomial using the binomial theorem
  - Use the binomial theorem to find a single term

#### 9.7 Probability

- Basic Probability
    - Compute the probability of equally likely outcomes
    - Compute the probability of the union of two events
    - Use the complement rule to compute probabilities
    - Compute probability using counting theory
-

- Binomial Probability
  - Identify a binomial experiment
  - Determine the binomial probability of success in an experiment performed multiple times