LEARNING OBJECTIVES

CHAPTER 1. Functions

Section 1. Functions and Their Graphs

1. Find the domain and range of a function.
2. Determine if a graph is a function.
3. Find a formula for a function.
4. Graph a function and determine its domain.
5. Graph piecewise-defined functions.
6. Find a formula for a piecewise-defined function from its graph.
7. Understand the greatest and least integer functions.
8. Determine where a graph is increasing or decreasing.
9. Identify even and odd functions.
10. Graph linear and power functions.
11. Solve applied problems using functions.

Section 2. Combining Functions; Shifting and Scaling Graphs

1. Find the domain and range of algebraic combinations of functions.
2. Find the domain and range of and sketch the graph of composites of functions.
3. Write the equation for and sketch the graph of a function that has been shifted vertically or horizontally.
4. Write the equation for and sketch the graph of a function that has been transformed by a vertical or horizontal scaling.
5. Write the equation for and sketch the graph of a function that has been transformed by a vertical or horizontal reflection.
6. Write the equation for and sketch the graph of a function that has been transformed by a combination of shifts, scalings, and reflections.

Section 3. Trigonometric Functions

1. Use the formula to find arc length.
2. Evaluate the six trigonometric functions of an angle.
3. Find the value of trigonometric functions given the value of one of them.
4. Graph trigonometric functions.
5. Derive trigonometric identities.
6. Use the angle addition formula.
7. Use the double angle and half-angle formulas.
8. Solve trigonometric equations.
9. Use the law of cosines and the law of sines.
10. Identify the characteristics of the general sine function.

Section 4. Graphing with Software

1. Determine the most appropriate viewing window.
2. Graph functions using the most appropriate window.
3. Make a scatterplot of data, and find the regression line or quadratic curve fit.

Section 5. Exponential Functions
1. Graph exponential functions.
2. Use the laws of exponents.
3. Understand exponential growth and decay.
4. Find the domain and range of composite functions that involve exponentials.
4. Use a graph of an exponential function to find an approximate solution to an equation.
5. Solve problems involving exponential models.

Section 6. Inverse Functions and Logarithms
1. Identify one-to-one functions graphically by using the horizontal line test.
2. Graph the inverse of a one-to-one function by using symmetry with respect to the line $y = x$.
3. Find the formula for the inverse of a one-to-one function.
4. Use properties of logarithms to simplify expressions.
5. Solve logarithmic or exponential equations.
6. Find common values of inverse trigonometric functions.
7. Solve theory and application problems involving inverse functions and logarithms.

CHAPTER 2. Limits and Continuity
Section 1. Rates of Change and Tangents to Curves
1. Find the average rate of change of a function over an interval.
2. Find the slope of the tangent line at a given point.
3. Solve applied problems using rates of change.

Section 2. Limit of a Function and Limit Laws
1. Find the limit from graphs of a function.
2. Find the limit of algebraic functions.
3. Find the limit of trigonometric functions.
4. Recognize the rules for limits.
5. Find the limit using the rules for limits.
6. Evaluate the limit of average rates of change.
7. Use the sandwich theorem.
8. Estimate limits using tables.
9. Find the limit of $f(x)$ given information about f.

Section 3. The Precise Definition of a Limit
1. Center intervals about a point.
2. Find delta graphically.
3. Find delta algebraically.
4. Use the formal definition to find limits.
5. Prove limit statements.
6. Solve applied problems involving limits.
7. Prove that a limit does not exist.

Section 4. One-Sided Limits
1. Find one-sided limits graphically.
2. Find one-sided limits algebraically.
3. Find the limit of trigonometric functions using $\lim \sin x/x = 1$.

4. Use the formal definition to find one-sided limits.

Section 5. Continuity
1. Determine where a function is continuous or discontinuous.
2. Use the algebraic properties of continuous functions to prove continuity.
3. Determine where a composite function is continuous.
4. Find limits involving continuous functions..
5. Fill in values to make a function continuous.
6. Use continuity and the Intermediate Value Theorem to solve problems.
7. Solve equations graphically.

Section 6. Limits Involving Infinity; Asymptotes of Graphs
1. Find limits graphically.
2. Find limits as x approaches infinity or negative infinity.
3. Find horizontal or oblique asymptotes.
4. Find limits where $f(x)$ approaches infinity or negative infinity.
5. Find vertical asymptotes.
6. Graph rational functions.
7. Understand the formal definition of a limits involving infinity.
8. Find and graph a function that satisfies given conditions.

CHAPTER 3. Derivatives
Section 1. Tangents and the Derivative at a Point
1. Find the slope of the tangent line at a given point.
2. Find the equation of the tangent line at a given point.
3. Find the point where the graph has a vertical or horizontal tangent.
4. Determine if a function has a tangent at a given point.
5. Find instantaneous rates of change and solve applications.

Section 2. The Derivative as a Function
1. Calculate a derivative from the definition.
2. Use the alternate formula for the derivative.
3. Compute one-sided derivates.
4. Determine where a function does not have a derivative.
5. Match a graph with the graph of its derivative.
6. Graph the derivative given the graph of a function.
7. Compute derivatives as limits to determine differentiability.
8. Determine differentiability and continuity from a graph.
9. Graph and analyze a function and its derivative.

Section 3. Differentiation Rules
1. Find derivatives using differentiation rules, including the product and quotient rules.
2. Compute second-order and higher-order derivatives.
2. Work with tangent or normal lines.
3. Solve theory and application problems for derivatives.

Section 4. The Derivative as a Rate of Change
1. Understand the relationship between derivatives and instantaneous rates of change.
2. Calculate quantities related to motion, including position, velocity, and acceleration.
3. Solve applications involving motion of a object under gravity.
4. Analyze motion from graphs.
5. Solve other applications of rate of change.

Section 5. Derivatives of Trigonometric Functions
1. Find derivatives of trigonometric functions.
2. Work with tangent lines of trigonometric functions.
3. Find limits that involve trigonometric functions.
4. Solve applications that involve trigonometric functions.

Section 6. The Chain Rule
1. Find derivatives of composite functions using the chain rule.
2. Find derivatives of powers of a function.
3. Find second derivatives using the chain rule.
4. Find the tangent to a curve at a given value.
5. Solve problems involving theory and applications related to the chain rule.

Section 7. Implicit Differentiation
1. Understand implicitly defined functions.
2. Use implicit differentiation to find derivatives.
3. Use implicit differentiation to find second derivatives.
4. Find the slope, tangent line, or normal line at a given point by using implicit differentiation.
5. Solve problems involving theory and applications related to implicit differentiation.

Section 8. Derivatives of Inverse Functions and Logarithms
1. Find the derivative of the inverse of a function.
2. Find derivatives of logarithmic functions.
3. Use logarithmic differentiation.
4. Find derivatives of mixed transcendental functions.

Section 9. Inverse Trigonometric Functions
1. Find common values of inverse trigonometric functions.
2. Find derivatives of inverse trigonometric functions.
3. Find limits involving inverse trigonometric functions.
4. Solve theory and application problems related to inverse trigonometric problems.

Section 10. Related Rates
1. Solve related rates problems.

Section 11. Linearization and Differentials
1. Find the linearization of a function at a given point.
2. Use the approximation $(1 + x)^k = 1 + kx$.
3. Find the derivative in differential form.
4. Use differentials to estimate the value of a function.

5. Use differentials to find the change in a function f, the value of the estimate df, and the approximation error.
6. Find differential formulas that estimate changes in volume or surface area.
7. Solve applications involving differentials.

CHAPTER 4. Applications of Derivatives

Section 1. Extreme Values of Functions
1. Find extrema from graphs.
2. Find the absolute extrema on finite closed intervals.
3. Find all critical points and local extrema of a function.
4. Find the extreme values and where they occur.
5. Solve applications involving extreme values.

Section 2. The Mean Value Theorem
1. Find the values that satisfy the conclusion of the mean value theorem.
2. Show that a function has exactly one zero in a given interval.
3. Find all possible functions that have a given derivative.
4. Find a function from a given derivative and a given point.
5. Find position from velocity or acceleration.
6. Solve theory and application problems involving the mean value theorem.

Section 3. Monotonic Functions and the First Derivative Test
1. Find intervals on which a function is increasing and decreasing.
2. Use the first derivative test to find local extrema.
3. Find local and absolute extrema in a given domain.
4. Graph a function given its first derivative.
5. Solve theory and application problems by using the first derivative test.

Section 4. Concavity and Curve Sketching
1. Identify inflection points, local extrema, and concavity from a graph.
2. Use the second derivative test to find intervals on which a function is concave up or down.
3. Use the second derivative test for local extrema.
4. Graph equations, find intervals on which the function is increasing/decreasing or concave up/down, find any local extrema, find inflection points, and find any asymptotes.
5. Graph $f(x)$ given the graphs of $f'(x)$ and $f''(x)$.
6. Graph rational functions.
7. Solve applications involving concavity.

Section 5. Indeterminate Forms and L'Hôpital's Rule
1. Recognize indeterminate forms where L'Hôpital's Rule is applicable.
2. Use L'Hôpital's Rule to find limits.
3. Use logarithms and L'Hôpital's rule to find limits involving indeterminate powers.
4. Solve theory and application problems involving limits.

Section 6. Applied Optimization
1. Solve mathematical and geometric problems involving optimization.
2. Solve physical problems involving optimization.

3. Solve business and economics problems involving optimization.

Section 7. Newton's Method
1. Use Newton's method to estimate solutions to problems.
2. Solve theory problems related to root-finding.

Section 8. Antiderivatives
1. Find an antiderivative or indefinite integral.
2. Check an antiderivative formula by computing a derivative.
3. Solve initial value problems.
4. Solve applications involving antiderivatives.

CHAPTER 5. Integrals
Section 1. Area and Estimating with Finite Sums
1. Estimate the area under the graph of a function by using upper and lower sums.
2. Solve applications involving estimating an integral.
3. Estimate the average value of a function.

Section 2. Sigma Notation and Limits of Finite Sums
1. Write a sum without sigma notation and evaluate.
2. Write a sum in sigma notation.
3. Find the value of a finite sum.
4. Apply the algebra rules for finite sums.
5. Graph a function and rectangles for a corresponding Reimann sum approximation.
6. Find the norm of a partition.
7. Find a formula for a Reimann sum and calculate the corresponding area.

Section 3. The Definite Integral
1. Express a definite integral as a limit, and a limit as a definite integral.
2. Use the definite integral rules.
3. Evaluate definite integrals by using known formulas and areas.
4. Find an area by evaluating a definite integral.
5. Find the average value of a function.
6. Solve theory problems involving definite integrals.

Section 4. The Fundamental Theorem of Calculus
1. Use the FTC to evaluate definite integrals.
2. Use the FTC to find derivatives of integrals.
3. Express the area of a region as a definite integral and evaluate.
4. Express the solution of an initial value problem as an integral.
5. Solve theory and application problems by using the FTC.

Section 5. Indefinite Integrals and the Substitution Method
1. Use the substitution method to evaluate indefinite integrals.
2. Solve initial value problems.
3. Solve applications involving integrals.

Section 6. Definite Integral Substitution and the Area Between Curves
1. Evaluate definite integrals by using the substitution formula.
2. Find the total area of a region.
3. Find the area of a region enclosed by lines and curves.
4. Solve theory and application problems involving integrals.

CHAPTER 6. Applications of Definite Integrals
Section 1. Volumes Using Cross-Sections
1. Find the volume of a solid by slicing.
2. Find the volume of a solid by the disk method.
3. Find the volume of a solid by the washer method.
4. Find the volume of a solid of revolution.
5. Solve theory and application problems involving volumes.

Section 2. Volumes Using Cylindrical Shells
1. Use the shell method to find the volume of a solid obtained by revolving a region about the y-axis.
2. Use the shell method to find the volume of a solid obtained by revolving a region about the x-axis.
3. Use the shell method to find the volume of a solid obtained by revolving the region about given lines.
4. Determine the appropriate method to use to find the volume of a solid of revolution.
5. Solve theory and application problems involving volumes.

Section 3. Arc Length
1. Find the arc length of a curve.
2. Solve theory and application problems involving arc length.

Section 4. Areas of Surfaces of Revolution
1. Find the area of a surface that has been revolved around the x-axis.
2. Find the area of a surface that has been revolved around the y-axis.
3. Solve theory and application problems involving area of surfaces.

Section 5. Work and Fluid Forces
1. Find the work done by a variable force moving an object.
2. Solve applications involving springs.
3. Find the work required to pump a liquid from a container.
4. Solve applications involving work and kinetic energy.
5. Find fluid forces.

Section 6. Moments and Centers of Mass
1. Find the center of mass of a thin plate with constant density.
2. Find the center of mass of a thin plate with varying density.
3. Find the moment or the center of mass of a thin wire.
4. Find the centroid of a thin plate bounded by curves.
5. Solve problems involving the theorems of Pappus.

CHAPTER 7. Integrals and Transcendental Functions

Section 1. The Logarithm Defined as an Integral
1. Understand the definition and properties of e^x and $\ln x$.
2. Evaluate integrals involving logarithms and exponentials.
3. Solve initial value problems.
4. Solve theory and application problems involving logarithms and exponentials.

Section 2. Exponential Change and Separable Differential Equations
1. Understand the definition of exponential change.
2. Solve initial value problems and differential equations.
3. Solve application problems involving exponential change.

Section 3. Hyperbolic Functions
1. Find the values of hyperbolic functions.
2. Rewrite expressions in terms of exponentials.
3. Find derivatives of hyperbolic functions.
4. Evaluate integrals of hyperbolic functions.
5. Rewrite expressions in terms of natural logarithms.
6. Evaluate integrals in terms of inverse hyperbolic functions and natural logarithms.
7. Solve theory and application problems related to hyperbolic functions.

Section 4. Relative Rates of Growth
1. Compare the growth rate of functions.
2. Characterize the growth of functions using big-oh and little-oh notation.
3. Solve comparison and other application problems involving rates of growth.

CHAPTER 8. Techniques of Integration

Section 1. Using Basic Integration Formulas
1. Evaluate integrals by using basic integration formulas and algebraic techniques.
2. Solve theory problems related to integrals.

Section 2. Integration by Parts
1. Evaluate indefinite and definite integrals by using integration by parts.
2. Find good choices for u and dv.
3. Evaluate integrals using a substitution prior to integration by parts.
4. Evaluate integrals that require two applications of integration by parts.
5. Evaluate integrals by using reduction formulas.
6. Solve theory and application problems involving integrals.

Section 3. Trigonometric Integrals
1. Evaluate integrals involving powers of sines and cosines.
2. Evaluate integrals involving square roots.
3. Evaluate integrals involving powers of tangents and secants.
4. Evaluate integrals involving products of sines and cosines.
5. Solve application problems involving trigonometric integrals.

Section 4. Trigonometric Substitutions
1. Recognize when a trigonometric substitution will be useful.
2. Evaluate integrals by using trigonometric substitutions.
3. Solve initial value problems.
4. Solve applications problems by using trigonometric substitutions.

Section 5. Integration of Rational Functions by Partial Fractions
1. Expand quotients by partial fractions.
2. Express integrands as a sum of partial fractions and evaluate the integrals.
3. Perform long division on the integrand and evaluate the integral.
4. Solve application problems by using partial fractions.

Section 6. Integral Tables and Computer Algebra Systems
1. Use tables of integrals to evaluate integrals.
2. Use substitution to change an integral into one found in a table of integrals.
3. Use a reduction formula to evaluate integrals.
4. Solve application problems.

Section 7. Numerical Integration
1. Estimate integrals using the trapezoidal rule and Simpson's rule.
2. Estimate the minimum number of subintervals needed to approximate integrals to within a specified error.
3. Estimate the error of an integral evaluated using the trapezoid rule or Simpson's rule.
4. Solve theory and application problems involving numerical integration.

Section 8. Improper Integrals
1. Write an improper integral with infinite limits of integration as a limit.
2. Evaluate improper integrals with infinite limits of integration.
3. Write an improper integral whose integrand has a singularity as a limit.
4. Evaluate improper integrals whose integrand has a singularity.
5. Test improper integrals for convergence or divergence.
6. Solve theory and application problems involving improper integrals.

Section 9. Probability
1. Show that a given function is a probability density function.
2. Find the probability that a random variable has values in a given interval.
3. Find the expected value, mean, and median of a random variable.
4. Find the variance and standard deviation of a random variable.
5. Solve application problems involving exponential or normal distributions.

CHAPTER 9. First-Order Differential Equations

Section 1. Solutions, Slope Fields, and Euler's Method
1. Recognize first-order differential equations.
2. Verify that a given function is a solution to a first-order initial value problem.
3. Given an equation involving integrals, write an equivalent first-order differential equation with initial condition.

4. Find the slope field for a differential equation.
5. Use Euler's Method to approximate solutions to an initial value problem.

Section 2. First-Order Linear Equations
1. Find the general solution to a first-order linear differential equations.
2. Find the particular solution to a first-order linear differential equation that satisfies a given initial condition.
3. Solve theory problems involving first-oder differential equations.

Section 3. Applications
1. Solve motion with resistance applications.
2. Find orthogonal trajectories.
3. Solve mixture problems.

Section 4. Graphical Solutions of Autonomous Equations
1. Determine stable and unstable equilibria.
2. Solve application problems involving autonomous differential equations.

Section 5. Systems of Equations and Phase Planes
1. Use phase-plane analysis to solve applications.

CHAPTER 10. Infinite Sequences and Series
Section 1. Sequences
1. Find terms of a sequence.
2. Find the formula for the nth term of a sequence.
3. Determine if a sequence is monotonic and bounded.
4. Determine if a sequence converges or diverges.
5. Find the limit of a sequence, if one exists.
6. Find the limit of a recursively defined sequence.
7. Solve theory and application problems involving sequences.

Section 2. Infinite Series
1. Find the formula for the nth partial sum of a series.
2. Find the sum of a series, if it converges.
3. Express repeating decimals as the ratio of two integers.
4. Use the *n*th-term test for divergence.
5. Find the sum of a geometric series and the values for which it converges.
6. Solve theory and application problems involving series.

Section 3. The Integral Test
1. Use the integral test to determine if a series converges or diverges.
2. Estimate bounds for the remainder when using the integral test.
3. Use the integral test to solve theory and application problems involving series.

Section 4. Comparison Tests
1. Use the comparison test to determine if a series converges or diverges.
2. Use the limit comparison test to determine if a series converges or diverges.

3. Use cmparison tests to solve theory and application problems involving series.

Section 5. Absolute Convergence; The Ratio and Root Tests
1. Use the Ratio Test to determine whether a series converges absolutely or diverges.
2. Use the Root Test to determine whether a series converges absolutely or diverges.
3. Solve theory problems involving the Root and Ratio Tests.

Section 6. Alternating Series, Absolute and Conditional Convergence
1. Determine if a series converges absolutely, converges conditionally, or diverges.
2. Estimate the error in approximating the sum of an alternating series.
3. Determine the number of terms needed to estimate the sum of an alternating series.
4. Approximate the sum of an alternating series given a specific magnitude of error.
5. Solve theory and application problems involving alternating series.

Section 7. Power Series
1. Find the radius and interval of convergence of a power series.
2. Determine whether a power series diverges, converges conditionally, or converges absolutely at the endpoints of the interval of convergence.
3. Use algebraic operations, term-by-term differentiation, and term-by-term integration to find the sum of a power series.
4. Solve theory and application problems involving power series.

Section 8. Taylor and Maclaurin Series
1. Find the nth Taylor polynomial for a function f at a point $x = a$.
2. Find the Taylor series for a function f at a point $x = a$.
3. Find the Maclaurin series for a function f.
4. Find the values of x for which a Taylor or Maclaurin series converges absolutely.
5. Solve theory problems involving Taylor or Maclaurin series.

Section 9. Convergence of Taylor Series
1. Use substitution and power series operations to find a Taylor series.
2. Show that a Taylor series converges at a given point by estimating the remainder term.
3. Estimate the error when $f(x)$ is approximated by the nth Taylor polynomial $P_n(x)$.
4. Determine how large n must be in order that the Taylor polynomial $P_n(x)$ approximate $f(x)$ to within a given accuracy.
5. Solve theory and application problems involving Taylor series.

Section 10. The Binomial Series and Applications of Taylor Series
1. Find terms of a binomial series.
2. Find a binomial series.
3. Use series to estimate the value of an integral within a specific error.
4. Find a polynomial that will approximate a function given by an integral to a given accuracy.
5. Use series to evaluate limits that involve indeterminate forms.
6. Use algebraic operations and common Taylor series to find the sum of a given series.
7. Solve theory and application problems involving Taylor series.
8. Use Euler's identity.

CHAPTER 11. Parametric Equations and Polar Coordinates

Section 1. Parametrizations of Plane Curves
1. Graph a curve given by a parametric equation.
2. Find and graph a Cartesian equation corresponding to a given parametric equation.
3. Find parametric equations that define a curve or the motion of a particle.
4. Graph parametric curves using a software package.

Section 2. Calculus with Parametric Curves
1. Given a parametric equation, find the parametric formulas for dy/dx and d^2y/dx^2.
2. Find the tangent to a curve given by a parametric equation.
3. Find the area enclosed by a parametrically defined curve.
4. Find the length of a parametrically defined curve.
5. Find the area of a surface of revolution corresponding to a parametrized curve.
6. Find the coordinates of the centroid of a region defined by a parametrized curve.
7. Solve theory and application problems involving parametric curves.

Section 3. Polar Coordinates
1. Find all of the polar coordinates of a given point.
2. Write Cartesian coordinates for given polar coordinates.
3. Write polar coordinates for given Cartesian coordinates.
4. Graph sets of points whose polar coordinates satisfy a given equation or inequality.
5. Convert polar equations to Cartesian equations.
6. Convert Cartesian equations to polar equations.

Section 4. Graphing in Polar Coordinates
1. Identify the symmetries of a curve and sketch its graph.
2. Find the slope of a curve given in polar coordinates at a given point.
3. Graph curves given in polar coordinates.

Section 5. Areas and Lengths in Polar Coordinates
1. Find the area of a region enclosed by a curve given in polar coordinates.
2. Find the length of a curve given in polar coordinates.

Section 6. Conic Sections
1. Sketch conic section and find quantities related to the conic section, such as vertices, foci, directrix, or asymptotes.
2. Find the standard form of a conic equation.
3. Solve problems involving shifted conic sections.
4. Solve theory and application problems related to conic sections.

Section 7. Conics in Polar Coordinates
1. Find the eccentricity, foci, and directrix of a conic section.
2. Find a standard-form equation in Cartesian coordinates.
3. Find the polar equation for a conic section.
4. Graph a conic section.

CHAPTER 12. Vectors and the Geometry of Space

Section 1. Three-Dimensional Coordinate Systems

1. Describe the set whose coordinates satisfy the given information.
2. Find the distance between points.
3. Find the center and radius of a sphere.
4. Write an equation for a sphere.
5. Solve theory and application problems related to points in space.

Section 2. Vectors

1. Find the component form of a vector.
2. Sketch vectors.
3. Find sums and scalar multiples of vectors.
4. Find the length and direction of a vector.
5. Find the midpoint of a line segment.
6. Solve theory and application problems involving vectors.

Section 3. The Dot Product

1. Find the dot product of two vectors.
2. Find the angle between two vectors.
3. Determine if vectors are orthogonal.
4. Find the projection of one vector onto another.
5. Solve theory and application problems involving dot products and orthogonal vectors.

Section 4. The Cross Product

1. Calculate the cross product of two vectors in $\mathbf{R}^3$.
2. Find the length and direction of a cross product of two vectors.
3. Find the area of a triangle or parallelogram in space.
4. Compute a triple scalar product of three vectors.
5. Find the volume of a parallelepiped.
6. Solve theory and application problems related to cross products.

Section 5. Lines and Planes in Space

1. Find parametrizations for lines and line segments in space.
2. Find the equation of a plane.
3. Find the distance from a point to a line or a plane.
4. Find the line of intersection of two planes and the angle between them.
5. Find the point at which a line meets a plane.
6. Solve theory and application problems involving lines and planes.

Section 6. Cylinders and Quadric Surfaces

1. Sketch cylinders and quadric surfaces.
2. Solve theory and application problems related to cylinders and quadric surfaces.

CHAPTER 13. Vector-Valued Functions and Motion in Space

Section 1. Curves in Space and Their Tangents

1. Find a particle's velocity and acceleration vectors.
2. Find the angle between the velocity and acceleration vectors.

3. Find parametric equations for the line tangent to a curve.
4. Solve theory and application problems involving motion along a curve.

Section 2. Integrals of Vector Functions; Projectile Motion
1. Integrate vector-valued functions.
2. Solve initial value problems.
3. Solve applications involing projectile motion.
4. Solve theory problems related to integration of vector functions.

Section 3. Arc Length in Space
1. Find the arc length of a curve.
2. Find the unit tangent vector to a curve.
3. Solve theory and application problems involving arc length.

Section 4. Curvature and Normal Vectors of a Curve
1. Find the unit tangent vector **T**, the curvature kappa, and the principal unit norm vector **N** for a plane curve.
2. Find the unit tangent vector **T**, the curvature kappa, and the principal unit norm vector **N** for a space curve.
3. Solve theory problems involving curvature.

Section 5. Tangential and Normal Components of Acceleration
1. Find tangential and normal components of acceleration.
2. Find the torsion function of a smooth curve.
3. Find the TNB frame for a curve.
4. Solve theory and application problems involving acceleration.

Section 6. Velocity and Acceleration in Polar Coordinates
1. Find velocity and acceleration in polar coordinates.
2. Solve problems related to Kepler's Laws.

CHAPTER 14. Partial Derivatives
Section 1. Functions of Several Variables
1. Evaluate a function of several variables at specified points.
2. Find the domain and range a function of two variables.
3. Sketch level curves of a function of two variables, or match level curves with a surface.
4. Sketch functions of two variables.
5. Sketch level surfaces for a function of three variables.
6. Find an equation for a level curve or level surface that passes through a given point.

Section 2. Limits and Continuity in Higher Dimensions
1. Determine if the limit of a function of several variables exists, and find the limit if it does exist.
2. Determine points of continuity for functions of several variables.
3. Use the two-path test to prove the nonexistence of a limit.
4. Use the sandwich theorem to find limits.
5. Use polar coordinates to find limits.

6. Use the epsilon-delta definition of a limit.

Section 3. Partial Derivatives
1. Calculate first-order partial derivatives.
2. Calculate second-order partial derivatives.
3. Use the limit definition to compute a partial derivative.
4. Use implicit differentiation to find a partial derivative.
5. Solve theory and application problems involving partial derivatives or partial differential equations.

Section 4. The Chain Rule
1. Use the chain rule with one independent variable.
2. Use the chain rule with multiple independent variables.
3. Use a branch diagram to write a chain rule formula for a derivative.
4. Use implicit differentiation.
5. Find partial derivatives at specified points.
6. Apply the multi-dimensional chain rule to solve applications.

Section 5. Directional Derivatives and Gradient Vectors
1. Calculate the gradient of a function at a given point.
2. Find directional derivatives.
3. Find the equation for the tangent line to a level curve and illustrate with a sketch.
4. Apply knowledge of gradients and directional derivatives to solve applications.

Section 6. Tangent Planes and Differentials
1. Find equations for tangent planes and normal lines to a surface.
2. Find parametric equations for the line tangent to a curve at a given point.
3. Estimate the change in a function of two or three variables.
4. Find the linearization of a function of two or three variables.
5. Find an upper bound for the error in the linearization.
6. Estimate error and sensitivity to change.
7. Solve theory and application problems related to tangent planes and differentials.

Section 7. Extreme Values and Saddle Points
1. Use the first derivative test to find local extrema of a function of two variables.
2. Use the second derivative test to find local extrema and saddle points of functions of two variables.
3. Find absolute extrema of a function of two variables.
4. Find extreme values on parameterized curves.
5. Solve theory and application problems involving extreme values and saddle points.

Section 8. Lagrange Multipliers
1. Solve applications involving two independent variables with one constraint.
2. Solve applications involving three independent variables with one constraint.
3. Solve applications involving three independent variables with two constraints.
4. Solve theoretical problem involving Lagrange multipliers.

Section 9. Taylor's Formula for Two Variables
1. Find quadratic and cubic approximations to a function of two variables.

Section 10. Partial Derivatives with Constrained Variables
1. Find partial derivatives of functions of constrained variables.

CHAPTER 15. Multiple Integrals
Section 1. Double and Iterated Integrals over Rectangles
1. Evaluate iterated integrals.
2. Evaluate double integrals over rectangles.
3. Find the volume beneath a surface.

Section 2. Double Integrals over General Regions
1. Sketch the region of integration.
2. Find limits of integration that define a region, and write an iterated integral that gives the area of a region.
3. Evaluate integrals over a region.
4. Write an equivalent double integral with the order of integration reversed.
5. Evaluate an integral by reversing the order of integration.
6. Find the volume beneath a surface.
7. Evaluate an integral over an unbounded region.
8. Approximate an integral with a finite sum.
9. Solve theoretical and applied problems related to double integrals.

Section 3. Area by Double Integration
1. Express the area of a region as a double integral and evaluate the integral.
2. Sketch the region indicated by the double integral, find the equations of the bounding curves, and evaluate the integral.
3. Find the average value of a function over a region.
4. Solve theory and application problems related to double integrals.

Section 4. Double Integrals in Polar Form
1. Describe a region in polar coordinates.
2. Change a Cartesian integral to polar form and evaluate.
3. Change a polar integral into Cartesian form and evaluate.
4. Find the area of a region using a polar double integral.
5. Find the average value of a function using a polar integral.
6. Solve theory and application problems involving polar integrals.

Section 5. Triple Integrals in Rectangular Coordinates
1. Evaluate triple integrals.
2. Write triple integrals in multiple orders of integration and evaluate.
3. Find volumes by using triple integrals.
4. Find the average value of a function of three variables.
5. Integrate by changing the order of integration.
6. Solve theory and application problems involving triple integrals.

Section 6. Moments and Centers of Mass
1. Find the mass, first moments, center of mass, and moments of intertia for plates of constant or varying density.
2. Find the mass, first moments, center of mass, and moments of intertia for solids of constant or varying density.
3. Solve theory and application problems involving moments and centers of mass.

Section 7. Triple Integrals in Cylindrical and Spherical Coordinates
1. Evaluate integrals in cylindrical or spherical coordinates.
2. Change the order of integration in cylindrical or spherical coordinates.
3. Find iterated integrals in cylindrical or spherical coordinates.
4. Find the volume of a solid using triple integrals.
5. Find the average value of a function over a solid.
6. Find the mass, center of mass, or moments of a solid.
7. Solve theory and application problems involving triple integrals.

Section 8. Substitutions in Multiple Integrals
1. Calculate the Jacobian of a transformation and sketch the transformed region.
2. Use transformations to evaluate double integrals.
3. Use transformations to evaluate triple integrals.
7. Solve theory and application problems involving substitutions in multiple integrals.

CHAPTER 16. Integration in Vector Fields

Section 1. Line Integrals
1. Graph vector equations.
2. Evaluate a line integral by finding a smooth parametrization of a curve.
3. Find masses and moments for coil springs, wires, and thin rods.

Section 2. Vector Fields and Line Integrals: Work, Circulation, and Flux
1. Find the gradient field of a function.
2. Find a line integral of a vector field over a given curve.
3. Find the work done by a force field moving an object over a curve in space.
4. Find the flow or circulation around a curve in a velocity field.
5. Find the flux across a simple closed plane curve.
6. Find a vector field that has given properties.

Section 3. Path Independence, Conservative Fields, and Potential Functions
1. Determine if a field is conservative.
2. Find a potential function for a given field.
3. Determine if a differential form is exact.
4. Use potential functions to evaluate line integrals.
5. Solve theory and application problems related to conservative fields.

Section 4. Green's Theorem in the Plane
1. Verify that Green's theorem holds for a given field over a given region.
2. Find the counterclockwise circulation and outward flux for a given field over a given curve.
3. Find the work done by a field in moving a particle along a curve.

4. Using Green's Theorem to evaluate line integrals in a plane.
5. Calculate areas by using Green's theorem.
6. Solve applied problems by using Green's theorem.

Section 5. Surfaces and Area
1. Find a parametrization of a surface.
2. Find the area of a surface.
3. Find a tangent plane to a parametrized surface.
4. Solve applied problems related to surfaces and area.

Section 6. Surface Integrals
1. Find the surface integral of a scalar function over a given surface.
2. Find the surface integral of a vector field over a given surface.
3. Find the flux of a vector field across a given surface.
4. Find masses and moments of thin shells.

Section 7. Stokes' Theorem
1. Find the curl of a vector field.
2. Use Stokes' theorem to find a circulation of a field around a given curve.
3. Find the integral of a curl vector field.
4. Use Stokes' theorem to calculate the flux of the curl of a field across a given surface.
5. Solve applied problems by using Stokes' theorem.

Section 8. The Divergence Theorem and a Unified Theory
1. Find the divergence of a field.
2. Use the divergence theorem to calculate outward flux across the boundary of a given region.
3. Solve theory and aplication problems related to divergence.

CHAPTER 17. Second-Order Differential Equations
Section 1. Second-Order Linear Equations
1. Find the general solution of a second-order linear differential equation.
2. Solve initial value problems involving second-order linear differential equations.

Section 2. Nonhomogeneous Linear Equations
1. Solve differential equations by the method of undetermined coefficients.
2. Solve differential equations by the method of variation of parameters.
3. Solve initial value problems by using the methods of this section.

Section 3. Applications
1. Solve applications involving differential equations.

Section 4. Euler Equations
1. Find the general solution to an Euler equation.
2. Solve initial value problems related to Euler equations.

Section 5. Power-Series Solutions
1. Use power series to find the general solution of a differential equation.