# Mastering Calculus 2

### 1. Review of Fundamental Concepts

* **1.1** Understanding Definite and Indefinite Integrals
* **1.2** The Fundamental Theorem of Calculus
* **1.3** Basic Integration Techniques
* **1.4** Review of Algebraic Manipulations for Integration

### 2. Techniques of Integration

* **2.1** Integration by Substitution
* **2.2** Integration by Parts
* **2.3** Trigonometric Integrals
  + **2.3.1** Integrating Products of Sine and Cosine
  + **2.3.2** Integrating Secant and Tangent Functions
* **2.4** Trigonometric Substitution
* **2.5** Integration of Rational Functions by Partial Fractions
* **2.6** Integrating Irrational Functions
* **2.7** Strategies for Integration
* **2.8** Numerical Integration
  + **2.8.1** The Trapezoidal Rule
  + **2.8.2** Simpson's Rule

### 3. Applications of Integration

* **3.1** Areas Between Curves
* **3.2** Volumes of Solids of Revolution
  + **3.2.1** Disk Method
  + **3.2.2** Washer Method
* **3.3** Cylindrical Shells
* **3.4** Arc Length and Surface Area
* **3.5** Physical Applications
  + **3.5.1** Work
  + **3.5.2** Center of Mass and Moments
  + **3.5.3** Fluid Pressure and Force
* **3.6** Probability Applications
  + **3.6.1** Probability Density Functions
  + **3.6.2** Cumulative Distribution Functions

### 4. Polar Coordinates and Parametric Equations

* **4.1** Polar Coordinates
  + **4.1.1** Plotting Polar Equations
  + **4.1.2** Converting Between Polar and Rectangular Coordinates
* **4.2** Calculus with Polar Coordinates
  + **4.2.1** Area in Polar Coordinates
  + **4.2.2** Arc Length in Polar Coordinates
* **4.3** Parametric Equations
  + **4.3.1** Parametric Curves
  + **4.3.2** Calculus with Parametric Equations
    - **4.3.2.1** Derivatives
    - **4.3.2.2** Arc Length and Surface Area

### 5. Sequences and Series

* **5.1** Sequences
  + **5.1.1** Limits of Sequences
  + **5.1.2** Monotonic and Bounded Sequences
* **5.2** Infinite Series
  + **5.2.1** Convergence and Divergence
  + **5.2.2** Geometric Series
  + **5.2.3** The n-th Term Test
* **5.3** Integral Test and Estimates of Sums
* **5.4** Comparison Tests
  + **5.4.1** Direct Comparison Test
  + **5.4.2** Limit Comparison Test
* **5.5** Alternating Series
  + **5.5.1** Alternating Series Test
  + **5.5.2** Absolute and Conditional Convergence
* **5.6** Ratio and Root Tests
* **5.7** Power Series
  + **5.7.1** Radius and Interval of Convergence
  + **5.7.2** Differentiation and Integration of Power Series
* **5.8** Taylor and Maclaurin Series
  + **5.8.1** Formulas and Common Series
  + **5.8.2** Applications and Approximations
* **5.9** Binomial Series
* **5.10** Applications of Series
  + **5.10.1** Solving Differential Equations
  + **5.10.2** Modeling with Series

### 6. Introduction to Differential Equations

* **6.1** Basic Concepts and Definitions
* **6.2** Separable Differential Equations
* **6.3** First-Order Linear Differential Equations
* **6.4** Applications
  + **6.4.1** Exponential Growth and Decay
  + **6.4.2** Cooling and Mixing Problems
* **6.5** Direction Fields and Euler's Method

### 7. Advanced Techniques and Applications

* **7.1** Improper Integrals
  + **7.1.1** Integrals over Infinite Intervals
  + **7.1.2** Integrals with Discontinuous Integrands
* **7.2** Special Functions
  + **7.2.1** Gamma and Beta Functions
* **7.3** Advanced Integration Techniques
  + **7.3.1** Reduction Formulas
  + **7.3.2** Integration Using Tables and Computer Algebra Systems
* **7.4** Laplace Transforms (Introductory Concepts)

### 8. Vectors and the Geometry of Space (Optional)

* **8.1** Three-Dimensional Coordinate Systems
* **8.2** Vectors in Space
  + **8.2.1** Vector Operations
  + **8.2.2** Dot Product and Cross Product
* **8.3** Equations of Lines and Planes
* **8.4** Cylinders and Quadric Surfaces

### 9. Multivariable Functions (Introduction)

* **9.1** Functions of Several Variables
* **9.2** Partial Derivatives
* **9.3** Multiple Integrals (Overview)

### 10. Preparing for Advanced Topics

* **10.1** Introduction to Fourier Series
* **10.2** Basics of Complex Analysis
* **10.3** Numerical Methods for Differential Equations
* **10.4** Advanced Problem-Solving Strategies

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This comprehensive table of contents is designed to guide you from the foundational concepts of Calculus 2 to more advanced topics, preparing you for higher-level mathematics and applications in physics, engineering, and beyond. Each section builds upon the previous ones, ensuring a solid understanding as you progress.

#math/calculus