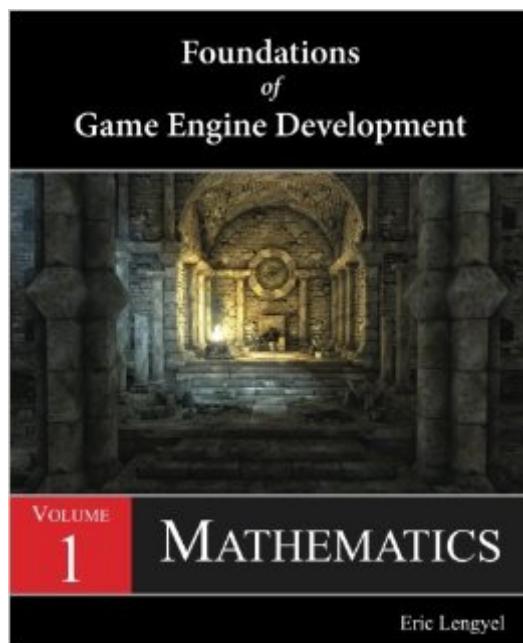


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# Foundations Of Game Engine Development, Volume 1: Mathematics



## Synopsis

The first volume of Foundations of Game Engine Development discusses the mathematics needed by engineers who work on games or other types of virtual simulations. The book begins with conventional treatments of topics such as linear algebra, transforms, and geometry. Then, it introduces Grassmann algebra and geometric algebra to provide a much deeper understanding of the subject matter and highlight the places where traditional arithmetic with vectors, matrices, quaternions, etc., isn't quite correct. Includes exercises.

Chapter 1: Vectors and Matrices

- 1.1 Vector Fundamentals
- 1.2 Basic Vector Operations

  - 1.2.1 Magnitude and Scalar Multiplication
  - 1.2.2 Addition and Subtraction

- 1.3 Matrix Fundamentals
- 1.4 Basic Matrix Operations

  - 1.4.1 Addition, Subtraction, and Scalar Multiplication
  - 1.4.2 Matrix Multiplication
  - 1.5 Vector Multiplication

    - 1.5.1 Dot Product
    - 1.5.2 Cross Product
    - 1.5.3 Scalar Triple Product

  - 1.6 Vector Projection
  - 1.7 Matrix Inversion

    - 1.7.1 Identity Matrices
    - 1.7.2 Determinants
    - 1.7.3 Elementary Matrices
    - 1.7.4 Inverse Calculation

  - 1.7.5 Inverses of Small Matrices

Chapter 2: Transforms

- 2.1 Coordinate Spaces

  - 2.1.1 Transformation Matrices
  - 2.1.2 Orthogonal Transforms
  - 2.1.3 Transform Composition

- 2.2 Rotations

  - 2.2.1 Rotation About a Coordinate Axis
  - 2.2.2 Rotation About an Arbitrary Axis
  - 2.3 Reflections
  - 2.4 Scales
  - 2.5 Skews
  - 2.6 Homogeneous Coordinates
  - 2.7 Quaternions

    - 2.7.1 Quaternion Fundamentals
    - 2.7.2 Rotations With Quaternions

Chapter 3: Geometry

- 3.1 Triangle Meshes
- 3.2 Normal Vectors

  - 3.2.1 Calculating Normal Vectors
  - 3.2.2 Transforming Normal Vectors

- 3.3 Lines and Rays

  - 3.3.1 Parametric Lines
  - 3.3.2 Distance Between a Point and a Line
  - 3.3.3 Distance Between Two Lines

- 3.4 Planes

  - 3.4.1 Implicit Planes
  - 3.4.2 Distance Between a Point and a Plane
  - 3.4.3 Reflection Through a Plane
  - 3.4.4 Intersection of a Line and a Plane
  - 3.4.5 Intersection of Three Planes
  - 3.4.6 Intersection of Two Planes
  - 3.4.7 Transforming Planes

- 3.5 Parameter Coordinates

  - 3.5.1 Implicit Lines
  - 3.5.2 Homogeneous Formulas
  - 3.5.3 Transforming Lines

Chapter 4: Advanced Algebra

- 4.1 Grassmann Algebra

  - 4.1.1 Wedge Product
  - 4.1.2 Bivectors
  - 4.1.3 Trivectors
  - 4.1.4 Algebraic Structure
  - 4.1.5 Complements
  - 4.1.6 Antivectors
  - 4.1.7 Antiwedge Product

- 4.2 Projective Geometry

  - 4.2.1 Lines
  - 4.2.2 Planes
  - 4.2.3 Join and Meet
  - 4.2.4 Line Crossing
  - 4.2.5 Plane Distance
  - 4.2.6 Summary and Implementation

- 4.3 Matrix Inverses
- 4.4 Geometric Algebra

  - 4.4.1 Geometric Product
  - 4.4.2 Vector Division
  - 4.4.3 Rotors

- 4.5 Conclusion

## Book Information

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This volume is compact, but concise: contains the elementary linear math required for graphics.

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