



Differential Equations and Linear Algebra

Gilbert Strang

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Differential equations and linear algebra are the two crucial courses in undergraduate mathematics. This new textbook develops those subjects separately and together. The complete book is a year's course, including Fourier and Laplace transforms, plus the Fast Fourier Transform and Singular Value Decomposition.

Undergraduate students in courses covering differential equations and linear algebra, either separately or together, will find this material essential to their understanding.

Contents: Preface; 1: First Order Equations; 1.1: Four Examples: Linear versus Nonlinear; 1.2: The Calculus you Need; 1.3: The Exponentials; 1.4: Four Particular Solutions; 1.5: Real and Complex Sinusoids; 1.6: Models of Growth and Decay; 1.7: The Logistic Equation; 1.8: Separable Equations and Exact Equations; 2: Second Order Equations; 2.1: Second Derivatives in Science and Engineering; 2.2: Key Facts About Complex Numbers; 2.3: Constant Coefficients A, B, C ; 2.4: Forced Oscillations and Exponential Response; 2.5: Electrical Networks and Mechanical Systems; 2.6: Solutions to Second Order Equations; 2.7: Laplace Transforms $Y(s)$ and $F(s)$; 3: Graphical and Numerical Methods; 3.1: Nonlinear Equations; 3.2: Sources, Sinks, Saddles, and Spirals; 3.3: Linearization and Stability in 2D and 3D; 3.4: The Basic Euler Methods; 3.5: Higher Accuracy with Runge-Kutta; 4: Linear Equations and Inverse Matrices; 4.1: Two Pictures of Linear Equations; 4.2: Solving Linear Equations by Elimination; 4.3: Matrix Multiplication; 4.4: Inverse Matrices; 4.5: Symmetric Matrices and Orthogonal Matrices; 5: Vector Spaces and Subspaces; 5.1: The Column Space of a Matrix; 5.2: The Nullspace of A : Solving $Av=0$; 5.3: The Complete Solution to $Av=b$; 5.4: Independence, Basis and Dimension; 5.5: The Four Fundamental Subspaces; 5.6: Graphs and Networks; 6: Eigenvalues and Eigenvectors; 6.1: Introduction to Eigenvalues; 6.2: Diagonalizing a Matrix; 6.3: Linear Systems $y = Ay$; 6.4: The Exponential of a Matrix; 6.5: Second Order Systems and Symmetric Matrices; 7: Applied Mathematics and ATA ; 7.1: Least Squares and Projections; 7.2: Positive Definite Matrices and the SVD; 7.3: Boundary Conditions Replace Initial Conditions; 7.4: Laplace's Equation; 7.5: Networks and the Graph Laplacian; 8: Fourier and Laplace Transforms; 8.1: Fourier Series; 8.2: The Fast Fourier Transform; 8.3: The Heat Equation; 8.4: The Wave Equation; 8.5: The Laplace Transform; 8.6: Convolution (Fourier and Laplace); Matrix Factorizations; Properties of Determinants; Index; Linear Algebra in a Nutshell.

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