

Exercises from the final edition of a popular engineering math text. A collection of 1361 mostly odd-numbered exercises. Worked at a mediocre skill level in Mathematica 10. Browse PDFs at the website link provided in the Code tab, or download notebooks from branches.

Note: In a deep GitHub paradox, branch transfer cannot take place while this readme is displayed.

The chapter contents:

CHAPTER 1 First-Order ODEs

- 1.1 Basic Concepts. Modeling
- 1.2 Geometric Meaning of $f'(x, y)$. Direction Fields, Euler's Method
- 1.3 Separable ODEs. Modeling
- 1.4 Exact ODEs. Integrating Factors
- 1.5 Linear ODEs. Bernoulli Equation. Population Dynamics
- 1.6 Orthogonal Trajectories
- 1.7 Existence and Uniqueness of Solutions for Initial Value Problems

CHAPTER 2 Second-Order Linear ODEs

- 2.1 Homogeneous Linear ODEs of Second Order
- 2.2 Homogeneous Linear ODEs with Constant Coefficients
- 2.3 Differential Operators
- 2.4 Modeling of Free Oscillations of a Mass-Spring System
- 2.5 Euler-Cauchy Equations
- 2.6 Existence and Uniqueness of Solutions. Wronskian
- 2.7 Nonhomogeneous ODEs
- 2.8 Modeling- Forced Oscillations. Resonance
- 2.9 Modeling- Electric Circuits
- 2.10 Solution by Variation of Parameters

CHAPTER 3 Higher Order Linear ODEs

- 3.1 Homogeneous Linear ODEs
- 3.2 Homogeneous Linear ODEs with Constant Coefficients
- 3.3 Nonhomogeneous Linear ODEs

CHAPTER 4 Systems of ODEs. Phase Plane. Qualitative Methods

- 4.1 Systems of ODEs as Models in Engineering Applications
- 4.3 Constant-Coefficient Systems. Phase Plane Method
- 4.4 Criteria for Critical Points. Stability
- 4.5 Qualitative Methods for Nonlinear Systems
- 4.6 Nonhomogeneous Linear Systems of ODEs

CHAPTER 5 Series Solutions of ODEs. Special Functions

- 5.1 Power Series Method
- 5.2 Legendre's Equation. Legendre Polynomials $P_n(x)$
- 5.3 Extended Power Series Method- Frobenius Method
- 5.4 Bessel's Equation. Bessel Functions $J_\nu(x)$
- 5.5 Bessel Functions of the $Y_\nu(x)$. General Solution

CHAPTER 6 Laplace Transforms

- 6.1 Laplace Transform. Linearity. First Shifting Theorem (s-Shifting)
- 6.2 Transforms of Derivatives and Integrals. ODEs
- 6.3 Unit Step Function (Heaviside Function). Second Shifting Theorem (t-Shifting)
- 6.4 Short Impulses. Dirac's Delta Function. Partial Fractions
- 6.5 Convolution. Integral Equations
- 6.6 Differentiation and Integration of Transforms. ODEs with Variable Coefficients
- 6.7 Systems of ODEs

CHAPTER 7 Linear Algebra-- Matrices, Vectors, Dets

- 7.1 Matrices, Vectors - Addition and Scalar Multiplication
- 7.2 Matrix Multiplication
- 7.3 Linear Systems of Equations. Gauss Elimination
- 7.4 Linear Independence. Rank of a Matrix. Vector Space
- 7.7 Determinants. Cramer's Rule
- 7.8 Inverse of a Matrix. Gauss-Jordan Elimination
- 7.9 Vector Spaces, Inner Product Spaces. Linear Transformations

CHAPTER 8 Linear Algebra - Matrix Eigenvalue Problems

- 8.1 The Matrix Eigenvalue Problem. Determining Eigenvalues and Eigenvectors
- 8.2 Some Applications of Eigenvalue Problems
- 8.3 Symmetric, Skew-Symmetric, and Orthogonal Matrices
- 8.4 Eigenbases. Diagonalization. Quadratic Forms
- 8.5 Complex Matrices and Forms

CHAPTER 9 Vector Differential Calculus. Grad, Div, Curl

- 9.1 Vectors in 2-Space and 3-Space
- 9.2 Inner Product (Dot Product)
- 9.3 Vector Product (Cross Product)
- 9.4 Vector and Scalar Functions and Their Fields. Vector Calculus- Derivatives
- 9.5 Curves. Arc Length. Curvature. Torsion
- 9.7 Gradient of a Scalar Field. Directional Derivative
- 9.8 Divergence of a Vector Field
- 9.9 Curl of a Vector Field

CHAPTER 10 Vector Integral Calculus. Integral Theorems

- 10.1 Line Integrals
- 10.2 Path Independence of Line Integrals
- 10.3 Calculus Review- Double Integrals.
- 10.4 Green's Theorem in the Plane
- 10.5 Surfaces for Surface Integrals
- 10.6 Surface Integrals
- 10.7 Triple Integrals. Divergence Theorem of Gauss
- 10.8 Further Applications of the Divergence Theorem
- 10.9 Stokes's Theorem

CHAPTER 11 Fourier Analysis

- 11.1 Fourier Series
- 11.2 Arbitrary Period. Even and Odd Functions. Half-Range Expansions
- 11.3 Forced Oscillations
- 11.4 Approximation by Trigonometric Polynomials
- 11.5 Sturm-Liouville Problems. Orthogonal Functions
- 11.6 Orthogonal Series. Generalized Fourier Series
- 11.7 Fourier Integral
- 11.8 Fourier Cosine and Sine Transforms
- 11.9 Fourier Transform. Discrete and Fast Fourier Transforms

CHAPTER 12 Partial Differential Equations (PDEs)

- 12.1 Basic Concepts of PDEs
- 12.3 Solution by Separating Variables. Use of Fourier Series
- 12.4 D'Alembert's Solution of the Wave Equation. Characteristics
- 12.6 Heat Equation- Sol'n by Fourier Series. Steady 2D Heat, Dirichlet Problems
- 12.7 Heat Equation- Modeling Long Bars. Sol'n by Fourier Integrals and Transforms
- 12.9 Rectangular Membrane. Double Fourier Series
- 12.10 Laplacian in Polar Coordinates. Circular Membrane. Fourier-Bessel Series
- 12.11 Laplace's Equation in Cylindrical and Spherical Coordinates. Potential
- 12.12 Solution of PDEs by Laplace Transforms

CHAPTER 13 Complex Numbers and Functions. Complex Differentiation

- 13.1 Complex Numbers and Their Geometric Representation
- 13.2 Polar Form of Complex Numbers. Powers and Roots
- 13.3 Derivative. Analytic Function
- 13.4 Cauchy-Riemann Equations. Laplace's Equation
- 13.5 Exponential Function
- 13.6 Trigonometric and Hyperbolic Functions. Euler's Formula
- 13.7 Logarithm. General Power. Principal Value

CHAPTER 14 Complex Integration

- 14.1 Line Integral in the Complex Plane
- 14.2 Cauchy's Integral Theorem
- 14.3 Cauchy's Integral Formula
- 14.4 Derivatives of Analytic Functions

CHAPTER 15 Power Series, Taylor Series

- 15.1 Sequences, Series, Convergence Tests
- 15.2 Power Series
- 15.3 Functions Given by Power Series
- 15.4 Taylor and Maclaurin Series
- 15.5 Uniform Convergence

CHAPTER 16 Laurent Series. Residue Integration

- 16.1 Laurent Series
- 16.2 Singularities and Zeros. Infinity
- 16.3 Residue Integration Method
- 16.4 Residue Integration of Real Integrals

CHAPTER 17 Conformal Mapping

- 17.1 Geometry of Analytic Functions- Conformal Mapping
- 17.2 Linear Fractional Transformations (Möbius Transformations)
- 17.3 Special Linear Fractional Transformations
- 17.4 Conformal Mapping by Other Functions
- 17.5 Riemann Surfaces

CHAPTER 18 Complex Analysis and Potential Theory

- 18.1 Electrostatic Fields
- 18.2 Use of Conformal Mapping. Modeling
- 18.3 Heat Problems
- 18.4 Fluid Flow
- 18.5 Poisson's Integral Formula for Potentials
- 18.6 Harmonic Functions. Uniqueness for Dirichlet Problem

CHAPTER 19 Numerics in General

- 19.1 Introduction
- 19.2 Solution of Equations by Iteration
- 19.3 Interpolation
- 19.4 Spline Interpolation
- 19.5 Numeric Integration and Differentiation

CHAPTER 20 Numeric Linear Algebra

- 20.1 Linear Systems- Gauss Elimination
- 20.2 Linear Systems- LU-Factorization, Matrix Inversion
- 20.3 Linear Systems- Solution by Iteration
- 20.4 Linear Systems- Ill-Conditioning, Norms
- 20.5 Least Squares Method
- 20.7 Inclusion of Matrix Eigenvalues
- 20.8 Power Method for Eigenvalues
- 20.9 Tridiagonalization and QR-Factorization

CHAPTER 21 Numerics for ODEs and PDEs

- 21.1 Methods for First-Order ODEs
- 21.2 Multistep Methods
- 21.3 Methods for Systems and Higher Order ODEs
- 21.4 Methods for Elliptic PDEs
- 21.5 Neumann and Mixed Problems. Irregular Boundary
- 21.6 Methods for Parabolic PDEs
- 21.7 Method for Hyperbolic PDEs

CHAPTER 22 Linear Programming

- 22.1 Unconstrained Optimization. Method of Steepest Descent
- 22.2 Linear Programming
- 22.3 Simplex Method
- 22.4 Simplex Method -- Difficulties

CHAPTER 23 Graphs, Optimization

- 23.1 Graphs and Digraphs
- 23.2 Shortest Path Problems. Complexity
- 23.3 Bellman's Principle. Dijkstra's Algorithm
- 23.4 Shortest Spanning Trees -- Greedy Algorithm
- 23.5 Shortest Spanning Trees -- Prim's Algorithm
- 23.6 Flows in Networks
- 23.7 Maximum Flow -- Ford-Fulkerson Algorithm
- 23.8 Bipartite Graphs. Assignment Problems

CHAPTER 24 Probability, Statistics

- 24.1 Data Representation. Average. Spread
- 24.2 Experiments, Outcomes, Events
- 24.3 Probability
- 24.4 Permutations and Combinations
- 24.5 Random Variables. Probability Distributions
- 24.6 Mean and Variance of a Distribution
- 24.7 Binomial, Poisson, and Hypergeometric Distributions
- 24.8 Normal Distribution
- 24.9 Distributions of Several Random Variables

CHAPTER 25 Mathematical Statistics

- 25.2 Point Estimation of Parameters
- 25.3 Confidence Intervals
- 25.4 Testing Hypotheses. Decisions
- 25.5 Quality Control
- 25.6 Acceptance Sampling
- 25.7 Goodness of Fit. Chi-squared Test
- 25.8 Nonparametric Tests
- 25.9 Regression. Fitting Straight Lines. Correlation