CONTENTS

Preface vii

1-1 Introduction

| 1-3 | Eigenvalues; Eigenvectors 8 |
|------|---|
| 1-4 | Inner-product Spaces 10 |
| 1-5 | Self-adjoint Transformations 12 |
| 1-6 | The Infinite-dimensional Case 16 |
| 1-7 | Operators 24 |
| 1-8 | Applications 29 |
| 1-9 | Banach Spaces and Linear Functionals 33 |
| 1-10 | Fixed-point Theorems and Applications 37 |
| 1-11 | Lebesgue Integration, a Survey 48 |
| 2. N | Nonlinear Algebraic and Transcendental Equations 53 |
| 2-1 | Introduction 53 |
| 2-2 | The Newton-Raphson Method 56 |
| 2-3 | The Method of Steepest Descent 70 |
| 2-4 | Saddle-point Method or Steepest-descent Method of Complex |
| | Integration 88 |

1. Linear and Nonlinear Transformations

1-2 Vector Spaces; Linear Transformations 5

| xiv | Contents | |
|--|---|--|
| 3. I | Nonlinear Optimization; Nonlinear Programming | |
| and Systems of Inequalities 93 | | |
| 3-1 | Introduction 93 | |
| 3-2 | Maxima, Minima, Quadratic Forms, and Convex Functions 96 | |
| 3-3 | Nonlinear Programming 103 | |
| 3-4 | Linear Programming 106 | |
| 3-5 | Characterization of the Optimum on the Boundary; Saddle Points; | |
| | Duality 113 | |
| 3-6 | Construction of Solutions 126 | |
| 3-7 | Optimization Problems with Infinitely Many Constraints 168 | |
| | | |
| 4. Nonlinear Ordinary Differential Equations 175 | | |
| 4-1 | Introduction 175 | |
| 4-2 | Some Nonlinear Equations 178 | |
| 4-3 | Existence and Uniqueness for First-order Systems 183 | |
| 4-4 | Linear Equations—Oscillatory Motion, Stability 188 | |
| 4-5 | Nonlinear Equations—Perturbation Method 199 | |

4-6

4-7

4-8

5-1

5-2

5-3

5-4

6-1

6-2

6-3

6-4

Equations)

4-11 Lyapunov Stability

Introduction

Introduction

214

4-12 General Methods of Solution

tions)

206

(Systems of Two Equations)

5. Introduction to Automatic Control and the Pontryagin Principle

> 276 Stability and a Class of Control Equations

> Functional Analysis and Optimum Control

6. Linear and Nonlinear Prediction Theory

Construction of the Discrete-case Estimate

Pontryagin's Maximum Principle

317

The Discrete Stationary Case

The Discrete Prediction Problem

Phase-plane Analysis-Stability Behavior in the Small (Systems of Two

Limit Cycles-Stability Behavior in the Large (Systems of Two Equa-

Topological Considerations: Indices and the Existence of Limit Cycles

276

281

323

302

225

217

254

320

327

4-10 Periodic Solutions of Nonlinear Systems with Periodic Coefficients

4-9 Periodic Solutions of Systems with Periodic Coefficients

| 6-5 | The Prediction Error 330 |
|------|--|
| 6-6 | The Special Case of Rational Densities 331 |
| 6-7 | The Continuous Stationary Case 333 |
| 6-8 | Construction of the Continuous-case Estimate 335 |
| 6-9 | The Continuous Prediction Problem 339 |
| 6-10 | Examples 342 |
| 6-11 | Conditional Expectation 345 |
| 6-12 | The General Estimation Problem 347 |
| 6-13 | Polynomial Estimation 351 |
| 6-14 | The Karhunen-Loeve Expansion 355 |
| 6-15 | Dynamical Systems with Control Variables 357 |
| | |

Appendix 365

Index 373