

CONTENTS

| | |
|---------------------|---|
| Introduction | 1 |
| References | 3 |

CHAPTER 1. **Spatial Approximations**

| | |
|--|----|
| 1.1 The Time-Dependent Group-Diffusion Equations | 4 |
| 1.2 The Spatial Finite-Difference Approximation | 7 |
| 1.3 Modal Expansion Approximations | 13 |
| 1.4 Nodal Approximation | 24 |
| 1.5 Point Kinetics | 28 |
| 1.6 Discussion | 32 |
| References | 37 |

CHAPTER 2. **Numerical Integration Methods for the Time Dependence**

| | |
|---|----|
| 2.1 Explicit Method—Forward Difference | 40 |
| 2.2 Implicit Integration—Backwards Difference | 42 |
| 2.3 Implicit Integration—“ θ ” Method | 43 |
| 2.4 Implicit Integration—Time-Integrated Method | 46 |
| 2.5 Perturbation Expansion Method | 48 |
| 2.6 Implicit Integration—GAKIN Method | 50 |
| 2.7 Alternating Direction Implicit Method | 54 |
| 2.8 Discussion | 56 |
| References | 57 |

CHAPTER 3. Variational Synthesis Methods

| | | |
|-----|---|----|
| 3.1 | A Simple Variational Synthesis Approximation | 60 |
| 3.2 | A Variational Functional | 64 |
| 3.3 | Multichannel Space-Time Synthesis Approximation | 70 |
| | References | 80 |

CHAPTER 4. Stochastic Kinetics

| | | |
|------|---|-----|
| 4.1 | Theory for a Forward Stochastic Model | 83 |
| 4.2 | Means, Variances, and Covariances | 87 |
| 4.3 | Correlation Functions | 89 |
| 4.4 | Physical Interpretation, Applications, Initial and Boundary Conditions | 90 |
| 4.5 | Numerical Studies | 92 |
| 4.6 | Relevance to Safeguards Analysis | 101 |
| 4.7 | Spatial Stochastic Effects | 103 |
| 4.8 | Theory for a Backwards Stochastic Model | 105 |
| 4.9 | The Langevin Technique | 108 |
| 4.10 | The Product Density Formulation | 111 |
| | References | 114 |

CHAPTER 5. Xenon Spatial Oscillations

| | | |
|-----|---|-----|
| 5.1 | Linear Stability Criteria | 119 |
| 5.2 | Nonlinear Stability Criterion | 127 |
| 5.3 | Control-Induced Xenon Spatial Transient Phenomena | 128 |
| 5.4 | Control of Xenon-Power Spatial Oscillations | 133 |
| | References | 138 |

CHAPTER 6. Stability

| | | |
|-----|--|-----|
| 6.1 | Classical Linear Stability Analysis | 140 |
| 6.2 | Lyapunov's Method | 142 |
| 6.3 | Input-Output/Computer Simulation | 145 |
| 6.4 | Lyapunov's Methods for Distributed Parameter Systems | 147 |
| | References | 149 |

CHAPTER 7. Control

| | | |
|-----|--|-----|
| 7.1 | Variational Methods of Modern Control Theory | 152 |
| 7.2 | Variational Synthesis of Optimal Solutions | 158 |

Contents

vii

| | | |
|-----|---|-----|
| 7.3 | Variational Methods for Spatially Dependent Control Problems | 161 |
| 7.4 | Control of Xenon Spatial Oscillations | 166 |
| | References | 173 |

| | | |
|----------|---|-----|
| APPENDIX | Derivation of Multigroup Diffusion Equations | 175 |
|----------|---|-----|

| | | |
|----------------------|--|-----|
| <i>Author Index</i> | | 181 |
| <i>Subject Index</i> | | 184 |