Contents

Preface ix

Acknowledgements xiii

Chapter 1 INTRODUCTORY REVIEW 1

Laplace and Fourier Transforms 3
Linear System Stability 14
Review of Probability Theory 21
Problems 26
References 29

Chapter 2 NEUTRON AND PRECURSOR EQUATIONS 30

Physical Data 31
Effective Values 39
Static Reactivity Calculations 47
Practical Calculations of Kinetics Parameters 49
Conclusion 52
Problems 53
References 55

Chapter 3 ELEMENTARY SOLUTIONS OF THE KINETICS EQUATIONS AT LOW POWER 56

Kinetics Parameters 56
Some Exact Solutions 59
Some Approximate Methods 66
Problems 71
References 75

Chapter 4 LINEAR REACTOR PROCESS DYNAMICS WITH FEEDBACK 76

Introduction 76
Neutronics Transfer Function 77
Void Effects 83
Reactor Thermal Transients 86
Reactor Plant Dynamics 96
Xenon Poisoning 103
Reactor Control Elements 114
Load Dynamics 119
Conclusion 121
Problems 122
References 127

Chapter 5 POWER REACTOR CONTROL SYSTEMS 128

Introduction 128
General Control Considerations 131
Sample Control Calculations 134
Light Water Reactors 144
Heavy Water Reactors 147
Gas Cooled Reactors 152
Sodium Cooled Reactors 155
Problems 158
References 195

Chapter 6 FLUCTUATIONS AND REACTOR NOISE 160

Introduction 160
Probability Equations 161
Correlation Functions 164
Experimental Applications 168
Conclusion 174
Problems 174
References 177

Chapter 7 SAFETY AND RELIABILITY 178

Introduction 178
Logical and Safety Circuits 182
Failure Expectations 190
Problems 198
References 199

Chapter 8 NONLINEAR SYSTEMS; STABILITY AND CONTROL 200

State Space Representations 201
Stability in Nonlinear Systems 204
Liapunov's Direct Stability Study 208
Application to Reactor Studies 213
Optimum Control Theory 215
Optimum Reactor Control 219
Conclusion 224
Problems 224
References 227

Chapter 9 ANALOGUE COMPUTING 228

Introduction 228
Linear Analogue Elements 230
Elementary Programs and Output 234
Computer Scaling 238
Additional Elements 244
Sample Programs 246
Conclusion 257
Problems 257
References 259

Index 261