## CONTENTS

Foreword to the First EditionxiiiPreface to the Second Edition ANS 2008 ReprintxvPreface to the Original Second EditionxviiPreface to the First Editionxxi

## Overview

1	Introduction 3	
	Nuclear Fuel Cycles	4
	Nuclear Power Reactors	10
	Exercises 20	
	Selected Bibliography	22

Basic Theory

- 2 Nuclear Physics 27 The Nucleus 28 Radioactive Decay 31 Nuclear Reactions 36 Nuclear Fission 41 **Reaction Rates** 46 Exercise 63 Selected Bibliography 64
- 3 Nuclear Radiation Environment 67 Interaction Mechanisms 69 Radiation Effects 72 Dose Estimates 79

vii

viii Co	ntents		
	Radiation Standards Exercises 94	87	
	Selected Bibliography	96	
4	Reactor Physics Infinite Systems 100	99 )	
	Finite Systems 108	112	
	Computational Methods Exercises 131	113	
	Selected Bibliography	133	
5	Reactor Kinetics and Neutron Multiplication Feedbacks 145	Control 136	135
	Control Applications Exercises 157	151	
	Selected Bibliography	159	
6	Fuel Depletion and FFuel Burnup162Transmutation163	Related Effects	161
	Fission Products 17		
	Operational Impacts Exercises 181	176	
	Selected Bibliography	182	
7	Reactor Energy Rem	oval 185	
	Power Distributions	187 191	
	Fuel-Pin Heat Transport Nuclear Limits 197	191	
	Exercises 205		
	Selected Bibliography	206	
	Nuclear Reactor Syst	ems	
8	Power Reactors: Eco		esign Principles
	Economics of Nuclear Po		
	Reactor Design Principles Reactor Fundamentals	s 226 231	
	Exercises 237	201	
	Selected Bibliography	240	
9	Reactor Fuel Design	and Utilization	n 241
	Fuel-Assembly Design	242	
	Utilization 254 Exercises 259		
	Selected Bibliography	260	

211

Contents ix

10	Light-Water Reactors261Boiling-Water Reactors262Pressurized-Water Reactors268Exercises282Selected Bibliography284	
11	Heavy-Water-Moderated and Graphite-Moderated Reactors287Heavy-Water-Moderated Reactors288Graphite-Moderated Reactors296Exercises308Selected Bibliography310	
12	Enhanced-Converter and Breeder Reactors313Spectral-Shift Converter Reactors315Thermal-Breeder Reactors317Fast Reactors321Exercises332Selected Bibliography333	
IV	Reactor Safety	
13	Reactor Safety Fundamentals337Safety Approach338Energy Sources340Accident Consequences343Exercises355Selected Bibliography356	
14	Reactor Safety Systems and Accident Risk359Engineered Safety Systems360Quantitative Risk Assessment384Advanced Reactors404Exercises410Selected Bibliography413	
15	Reactor Operating Events, Accidents, and Their LessonsSignificant Events419TMI-2 Accident423Chernobyl Accident450Common Accident Lessons467Exercises468Selected Bibliography472	417
16	Regulation and Administrative Guidelines475Legislation and Its Implementation476Reactor Siting480Reactor Licensing487	

Contents

	Administrative Guidelines495Exercises500Selected Bibliography503	
V	The Nuclear Fuel Cycle	
17	Fuel Cycle, Uranium Processing, and Enrichment50Nuclear Fuel Cycle508Uranium513Exercises532Selected Bibliography533	07
18	Fuel Fabrication and Handling535Fabrication536Fuel Recycle541Spent Fuel546Exercises553Selected Bibliography557	
19	Reprocessing and Waste Management559Reprocessing560Fuel-Cycle Wastes566Waste Management573Exercises593Selected Bibliography596	
20	Nuclear Material Safeguards599Special Nuclear Materials601Domestic Safeguards604International Safeguards618Fuel-Cycle Alternatives625Exercises628Selected Bibliography630	
VI	Nuclear Fusion	
21	Controlled Fusion635Fusion Overview636Magnetic Confinement643Inertial Confinement650Commercial Aspects655Non-Thermonuclear Fusion659Exercises661Selected Bibliography662	

x

Appendixes

- I Nomenclature 667
- II Units and Conversion Factors 671
- III The Impending Energy Crisis: A Perspective on the Need for Nuclear Power 677
  Energy Crisis 678
  Options 683
  Proposed Solutions 694
  Exercises 698
  Selected Bibliography 702
- IV Reference Reactor Characteristics 707

Answers to Selected Exercises 719 General Bibliography 721 Index 747