## PART 1: INTRODUCTION  1

1 **Introduction**  3

1.1 Purpose of This Textbook  3

1.2 Prerequisites  5

1.3 How to Use This Textbook  5

1.4 Actuarial Work and the Actuarial Profession  6

2 **Actuarial Science and the Actuarial Profession**  7

2.1 A Brief History of Actuarial Science and the Actuarial Profession  7

2.2 What Actuaries Do and What Sets Them Apart  9

2.3 Financial Security Systems  13

2.4 Insurance Industry Overview  23

2.5 Actuarial Areas of Practice  26

2.6 Key Competencies for Actuaries  34

3 **The Actuarial Control Cycle**  39

3.1 Introduction  39

3.2 Versions and Evolution of the Actuarial Control Cycle  40

3.3 An Expanded Discussion of the Control Cycle  45

3.4 Control Cycle Examples  47

3.5 Some Conclusions about Actuarial Work and the Control Cycle  51

4 **Principles of Actuarial Science**  53

## PART 2: INVESTMENTS  55

5 **Introduction and External Factors**  57

5.1 Overview of Investments Section  57

5.2 External Factors Affecting Investment Decisions  57
6 Interest Theory 65
6.1 Types of Interest Rates 65
6.2 Two Approaches to Interest 69
6.3 Capital Budgeting 71
6.4 Annuities 75

7 Asset Types 85
7.1 Underlying Assets 85
7.2 Derivatives 92
7.3 Assets Used in Insurance Company Portfolios 100

8 Investing/Portfolio Management 103
8.1 Introductory Investment Issues 103
8.2 Mean-Variance Analysis 107
8.3 Other Issues 113

9 Finance Models and Data 121
9.1 Capital Asset Pricing Model 121
9.2 Other Financial Modeling Frameworks 126
9.3 Data and Estimation 133

10 The Term Structure of Interest Rates 139
10.1 Interest Rates 139
10.2 Yield Curves 143

11 Asset and Liability Management 151
11.1 Interest Rate Sensitivity 151
11.2 Immunization 159
11.3 More on Asset and Liability Matching 162
11.4 Asset and Liability Management Risk Measures for Life Insurance Companies 164
PART 3: LIFE INSURANCE AND ANNUITIES  169

12  Introduction  171

13  Types of Coverage  173
   13.1 Life Insurance  173
   13.2 Annuities  213

14  External Forces and Life and Annuity Products  231
   14.1 Cultural and Social Factors  231
   14.2 Demographic Trends  232
   14.3 Economic and Business Environment  235
   14.4 Government Influences  236

15  Pricing  241
   15.1 Measuring Profitability  241
   15.2 Profit Measures  244

16  Profit Testing  253
   16.1 Approaches to Profit Testing  253
   16.2 Pricing Tools  261
   16.3 Asset Shares  261
   16.4 Analysis of Book Profits  267
   16.5 Sources of Profit  280
   16.6 Company Models  282

17  Inputs for Profit Testing  289
   17.1 Investment Income  289
   17.2 Equity Returns  289
   17.3 Mortality  290
   17.4 Persistency  290
   17.5 Expenses  291
18 Regulatory Influences on Profit Testing 295
  18.1 Reserves 295
  18.2 Reserve Model 298
  18.3 Nonforfeiture Requirements 321
  18.4 Income Taxes 331
  18.5 Required Surplus 331
  18.6 Premiums 332

19 Monitoring Results 337
  19.1 Why Monitor Experience 337
  19.2 What to Monitor 337

20 Closing 341

PART 4: RETIREMENT BENEFITS 343

21 Introduction to Retirement Plans 345
  21.1 External Forces Underlying the Need for a Retirement Income System 345
  21.2 History of Retirement Plans 355

22 Overview of Retirement Financial Security Systems 359
  22.1 Most Common Types of Formal Retirement Plans 359
  22.2 Government-Sponsored Social Security Systems 362
  22.3 Employer-Sponsored Retirement Programs 375
  22.4 Tax Structure of U.S. Employer-Sponsored Pensions 376
  22.5 The Role of the Courts in Retirement Plans 382
  22.6 Canadian Employer-Sponsored Pensions 383
  22.7 U.K. Pension System 385
  22.8 Mexican Pension System 386
  22.9 The Actuary's Role in Employer-Sponsored Defined Benefit Pensions 386
  22.10 Advantages of Having Retirement Income from Multiple Sources 387

23 Retirement Plan Design 389
  23.1 Defined Benefit and Defined Contribution Plans 389
  23.2 Hybrid Plan Design 394
<table>
<thead>
<tr>
<th>Page</th>
<th>Section</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>28.4</td>
<td>Overview of Health Economics</td>
<td>437</td>
</tr>
<tr>
<td>28.5</td>
<td>Key Influences on Health Care Funding Models</td>
<td>443</td>
</tr>
<tr>
<td>28.6</td>
<td>Overview of Disability Insurance</td>
<td>445</td>
</tr>
<tr>
<td>28.7</td>
<td>Overview of Long-Term Care Insurance</td>
<td>446</td>
</tr>
<tr>
<td>28.8</td>
<td>Overview of Group Life Insurance</td>
<td>447</td>
</tr>
<tr>
<td>29</td>
<td>External Factors</td>
<td>449</td>
</tr>
<tr>
<td>29.1</td>
<td>Forces Driving the Need for Benefit Plans</td>
<td>449</td>
</tr>
<tr>
<td>29.2</td>
<td>Cultural and Social Values</td>
<td>450</td>
</tr>
<tr>
<td>29.3</td>
<td>Demographics</td>
<td>451</td>
</tr>
<tr>
<td>29.4</td>
<td>Impact of Policy and Regulation</td>
<td>452</td>
</tr>
<tr>
<td>30</td>
<td>Pricing for Group Benefit Plans</td>
<td>457</td>
</tr>
<tr>
<td>30.1</td>
<td>Data and Assumptions</td>
<td>457</td>
</tr>
<tr>
<td>30.2</td>
<td>Network Management and Plan Design</td>
<td>459</td>
</tr>
<tr>
<td>30.3</td>
<td>Estimating Claims Costs</td>
<td>459</td>
</tr>
<tr>
<td>30.4</td>
<td>Projecting Costs to the Rating Period</td>
<td>466</td>
</tr>
<tr>
<td>30.5</td>
<td>Calculating Benefit Factors</td>
<td>469</td>
</tr>
<tr>
<td>30.6</td>
<td>Impact of Benefit Changes</td>
<td>472</td>
</tr>
<tr>
<td>30.7</td>
<td>Calculating Manual Gross Premiums</td>
<td>473</td>
</tr>
<tr>
<td>30.8</td>
<td>Experience Rating</td>
<td>477</td>
</tr>
<tr>
<td>31</td>
<td>Reserving</td>
<td>487</td>
</tr>
<tr>
<td>31.1</td>
<td>Definitions of Terms</td>
<td>487</td>
</tr>
<tr>
<td>31.2</td>
<td>Short-Term Reserves</td>
<td>490</td>
</tr>
<tr>
<td>31.3</td>
<td>Long-Term Reserves</td>
<td>498</td>
</tr>
<tr>
<td>31.4</td>
<td>Evaluating Claim Reserve Adequacy</td>
<td>503</td>
</tr>
<tr>
<td>31.5</td>
<td>Guidelines and Practice Standards for Reserves</td>
<td>504</td>
</tr>
</tbody>
</table>

Bibliography 505

Index 509