

Fundamentals of
Engineering
Economics

THIRD EDITION

Chan S. Park

*Department of Industrial and Systems Engineering
Auburn University*

PEARSON

Upper Saddle River Boston Columbus San Francisco New York
Indianapolis London Toronto Sydney Singapore Tokyo Montreal
Dubai Madrid Hong Kong Mexico City Munich Paris Amsterdam Cape Town

Vice President and Editorial Director, ECS:

Marcia J. Horton

Executive Editor: *Holly Stark*

Editorial Assistant: *Carlin Heinle*

Vice-President, Production: *Vince O'Brien*

Executive Marketing Manager: *Tim Galligan*

Marketing Assistant: *Jon Bryant*

Permissions Project Manager: *Jen Roach*

Senior Managing Editor: *Scott Disanno*

Production Project Manager/Editorial Production

Manager: *Greg Dulles*

Cover Designer: *Laura C. Ierardi*

Composition: *Jouve India Private Limited*

Full-Service Project Management: *Jouve India Private Limited*

Printer/Binder: *Edwards Brothers*

Typeface: Times Ten 10/12

Copyright © 2013, 2008, 2004 Pearson Education, Inc., publishing as Prentice Hall, One Lake Street, Upper Saddle River, New Jersey 07458. All rights reserved. Manufactured in the United States of America. This publication is protected by Copyright, and permission should be obtained from the publisher prior to any prohibited reproduction, storage in a retrieval system, or transmission in any form or by any means, electronic, mechanical, photocopying, recording, or likewise. To obtain permission(s) to use material from this work, please submit a written request to Pearson Education, Inc., Permissions Department, One Lake Street, Upper Saddle River, New Jersey 07458.

Many of the designations by manufacturers and seller to distinguish their products are claimed as trademarks. Where those designations appear in this book, and the publisher was aware of a trademark claim, the designations have been printed in initial caps or all caps.

All rights reserved. No part of this book may be reproduced, in any form or by any means, without permission in writing from the publisher.

The author and publisher of this book have used their best efforts in preparing this book. These efforts include the development, research, and testing of the theories and programs to determine their effectiveness. The author and publisher make no warranty of any kind, expressed or implied, with regard to these programs or the documentation contained in this book. The author and publisher shall not be liable in any event for incidental or consequential damages in connection with, or arising out of, the furnishing, performance, or use of these programs.

Library of Congress Cataloging-in-Publication Data

Park, Chan S.

Fundamentals of engineering economics / Chan S. Park.—3rd ed.

p. cm.

Includes bibliographical references and index.

ISBN 978-0-13-277542-7 (alk. paper)—ISBN 0-13-277542-5 (alk. paper) 1. Engineering economy. I. Title.

TA1774.P3695 2012

658.15—dc23

2011042173

PEARSON

10 9 8 7 6 5 4 3 2 1

ISBN-13: 978-0-13-277542-7

ISBN-10: 0-13-277542-5

To my mentors: James R. Buck (late),
Gerald J. Thuesen, and
Vernon E. Unger

PREFACE

Why Fundamentals of Engineering Economics?

Engineering economics is one of the most practical subject matters in the engineering curriculum, but it is an always challenging, ever-changing discipline. *Contemporary Engineering Economics (CEE)*, now in its fifth edition, was first published in 1993, and since then, we have tried to reflect changes in the business world in each new edition along with the latest innovations in education and publishing. These changes have resulted in a better, more complete textbook, but one that is much longer than it was originally intended. This may present a problem: Today, covering the textbook in a single term is increasingly difficult. Therefore, we decided to create *Fundamentals of Engineering Economics (FEE)* for those who like *contemporary* but think a smaller, more concise textbook would better serve their needs.

Goals of the Text

This text aims not only to provide sound and comprehensive coverage of the concepts of engineering economics but also to address the practical concerns of engineering economics. More specifically, this text has the following goals:

1. To build a thorough understanding of the theoretical and conceptual basis upon which the practice of financial project analysis is built.
2. To satisfy the very practical needs of the engineer toward making informed financial decisions when acting as a team member or project manager for an engineering project.
3. To incorporate all critical decision-making tools—including the most contemporary, computer-oriented ones that engineers bring to the task of making informed financial decisions.
4. To appeal to the full range of engineering disciplines for which this course is often required: industrial, civil, mechanical, electrical, computer, aerospace, chemical, and manufacturing engineering as well as engineering technology.

Intended Market and Use

This text is intended for use in introductory engineering economics courses. Unlike the larger textbook (*CEE*), it is possible to cover *FEE* in a single term and perhaps even to supplement it with a few outside readings or case studies. Although the chapters in *FEE* are arranged logically, they are written in a flexible, modular format, allowing instructors to cover the material in a different sequence.

New to This Edition

Much of the content has been streamlined to provide materials in depth and to reflect the challenges in contemporary engineering economics. Some of the highlighted changes are as follows:

- All chapter opening vignettes—a trademark of *Fundamentals of Engineering Economics*—have been revised or completely replaced with more current and thought-provoking examples from both service and manufacturing sectors.

Chapters	Chapter Opening Vignettes	Company	Sector	Industry
1	• Social networking	Facebook	Technology services	Internet software/Services
2	• Powerball lottery	Personal	Consumer	Gaming
3	• Credit cards	Personal	Financial	Banking
4	• Dallas Cowboys	Dallas Cowboys	Entertainment	Sports
5	• LCD glass manufacturing	Corning Glass	Manufacturing	Electronic components
6	• Owning a corporate jet	Hawker Beechcraft Corporation	Electronic technology	Aerospace/Defense
7	• What's a degree really worth?	Personal	Consumer	Education
8	• High-speed Internet	Australian Government	Public	Computer communication
9	• Obama to propose tax write-off for business	U.S. Government	Public	Taxation
10	• Coke leveraging its investment in plant-based packaging	Coca Cola	Consumer nondurables	Beverages/Packaging
11	• Japanese oil company looks to the rising sun	Solar Frontier KK's	Energy	Integrated oil
12	• Finding a fix for the Tappan Zee Bridge	State of New York	Public	Construction
13	• Warren Buffett	Berkshire Hathaway	Finance	Property/Insurance

- **Self-Test Questions** have been added at the end of each chapter (131 problems in total), and worked-out solutions to the questions are provided in Appendix A. These questions are formatted in a style suitable for Fundamentals Engineering Exam review and were created to help students prepare for a typical class exam common to introductory engineering economic courses.

- The Benefit–Cost Analysis section has been moved to Chapter 8 as a part of measure of investment chapters. The profitability index is included in this chapter.
- Most of the end-of-chapter problems are revised to reflect the changes in the main text. There are 708 problems, including 131 self-test questions, 43% of which are new or updated.
- Various Excel® spreadsheet modeling techniques are introduced throughout the chapters, and the original Excel files are provided online at the Companion Website. Most worksheets have been redesigned with graphical outputs.
- Some other specific content changes made in the third edition are as follows:
 - In Chapter 1, a cost reduction (Apple’s iPad®) project is introduced.
 - In Chapter 2, a new retirement planning example is introduced.
 - In Chapter 4, all CPI- and inflation-related data have been updated.
 - In Chapter 5, an example of comparing mutually exclusive revenue projects is provided.
 - In Chapter 6, a section on capital cost has been expanded with an automobile ownership example.
 - In Chapter 8, benefit–cost contents have been streamlined, and a new section on the profitability index has been created.
 - In Chapter 11, the section on risk-adjusted discount rate approach is expanded in which the risk element is incorporated through the cost of capital.
 - In Chapter 13, all financial statements for Lam Research Corporation have been updated, and a new set of financial ratio analysis is provided. Investment strategies have been added as a part of managing personal financial asset under uncertainty.

Features of the Book

FEE is significantly different from *CEE*, but most of the chapters will be familiar to users of *CEE*. Although we pruned some material and clarified, updated, and otherwise improved all of the chapters, *FEE* should still be considered an alternative and streamlined version of *CEE*.

We did retain all of the pedagogical elements and supporting materials that helped make *CEE* so successful. For example:

- Each chapter opens with a real economic vignette describing how an individual decision maker or actual corporation has wrestled with the issues discussed in the chapter. These opening cases heighten students’ interest by pointing out the real-world relevance and applicability of what might otherwise seem to be dry technical material.
- In working out each individual chapters example problems, students are encouraged to highlight the critical data provided by each question, isolate the question being asked, and outline the correct approach in the solution under the headings **Given**, **Find**, **Approach**, and **Comments**, respectively. This convention is employed throughout the text. This guidance is intended to stimulate student curiosity to look beyond the mechanics of problem solving to explore “what-if” issues, alternative solution methods, and the interpretation of the solutions.
- There are a large number of end-of-chapter problems and exam-type questions varying in level of difficulty; these problems thoroughly cover the book’s various topics.

- Most chapters contain a section titled “Short Case Studies with Excel,” enabling students to use Excel to answer a set of questions. These problems reinforce the concepts covered in the chapter and provide students an opportunity to become more proficient with the use of an electronic spreadsheet.
- All Excel spreadsheets now contain easy-to-follow call-out formulas. The integration of Excel is another important feature of *FEE*. Students have increased access to and familiarity with Excel, and instructors have more inclination either to treat these topics explicitly in the course or to encourage students to experiment independently. One could argue that the use of Excel will undermine true understanding of course concepts. This text does not promote the trivial or mindless use of Excel as a replacement for genuine understanding of and skill in applying traditional solution methods. Rather, it focuses on Excel’s productivity-enhancing benefits for complex project cash flow development and analysis.

To Student: How to Prepare for the Fundamentals of Engineering (FE) Exam

The set of self-study questions at the end of each chapter is designed primarily to help you develop a working knowledge of the concepts and principles of engineering economics. However, the questions are also perfect resource to help you prepare the Fundamentals of Engineering (FE) exam. All questions are structured in multiple-choice format because these types of exam questions are used in the FE exam and, increasingly, in introductory engineering economics courses.

The FE exam typically consists of 180 multiple-choice questions. During the morning session (120 questions), all examinees take a general exam common to all disciplines. During the afternoon session (60 questions), examinees can opt to take a general exam or a discipline-specific (Chemical, Civil, Electrical, Environmental, Industrial, or Mechanical) exam.

The general exam includes four questions related to engineering economics in the morning session and five in the afternoon session. The specific engineering economics topics covered in the FE exam are

- Discounted cash flow (e.g., equivalence, PW, equivalent annual, FW, and rate of return)
- Cost (e.g., incremental, average, sunk, estimating)
- Analyses (e.g., breakeven, benefit–cost)
- Uncertainty (e.g., expected value and risk)
- Valuation and depreciation

Some sample questions are also provided by the National Council of Examiners for Engineering and Surveying (www.ncees.org/exams).

Companion Book Website

A Companion Website (www.pearsonhighered.com/park) has been created and maintained by the publisher. This text takes advantage of the Internet as a tool that has become increasingly important in accessing a variety of information. The website contains a variety of resources for both instructors and students, including various online

financial calculators. As you type the address and click the open button, you will see the *Fundamentals of Engineering Economics* home page. There are three main links on the Companion Website:

- *Instructor Resources:* This is a password-protected link for registered instructors where the Instructor's Manual and PowerPoint slides for lecture notes can be found. A comprehensive *Instructor's Manual* in Word® format includes answers to end-of-chapter problems and Excel® solutions to all complex problems.
- *Student Resources:* This is where students can access online financial tools such as (1) Interest Factor Tables, (2) Cash Flow Analyzer, (3) Depreciation Analysis, and (4) Loan Analysis. The **Cash Flow Analyzer** is an integrated computer software package written in Java®. The software includes the most frequently used methods of economic analysis. It is menu-driven for convenience and flexibility, and it provides (1) a flexible and easy-to-use cash flow editor for data input and modifications and (2) an extensive array of computational modules and user-selected graphic outputs.
- *Author's Resource Website:* This content has been created and maintained by the author and contains several pieces of information useful in conducting engineering economic analyses.
 - *Tax Information:* This section will serve as a clearinghouse for disseminating ever-changing tax information, personal as well as corporate. Links are provided to various tax sites on the Web, so you will find the most up-to-date information on depreciation schedules as well as capital gains taxes.
 - *Money and Investing:* This section provides a gateway to a variety of information useful in conducting engineering economic analysis. For example, a direct link is provided to the most up-to-date stock prices, options, and mutual fund performances.
 - *Economic Tracks:* This section includes cost and price information as well as the most recent interest rate trends. In particular, the consumer price indices, productivity figures, and employment cost indices are some of the representative economic data provided.
 - *Financial News:* This section provides access to various financial news outlets on the Web. The site divides news outlets into online news and daily, weekly, and monthly publications.

Acknowledgments

This book reflects the efforts of a great many individuals over a number of years. In particular, I would like to recognize the following individuals whose reviews and comments for the previous editions have contributed to this edition. Once again, I would like to thank each of them:

- Roland K. Arter, *Summit College—University of Akron*
- Kandace Ballard, *Quorum Business Solutions, Inc.*
- John L. Evans, *Auburn University*
- Dolores Gooding, *University of South Florida*
- Bruce Hartsough, *University of California at Davis*

- Kyongsun Kim, *Republic of Korea Army*
- Hwansik Lee, *Republic of Korea Army*
- Matthew Marshall, *Rochester Institute of Technology*
- Bruce McCann, *University of Texas at Austin*
- Michael Park, *Mckinsey & Company*
- Richard V. Petitt, *United States Military Academy*
- Linda Ann Riley, *Roger Williams University*
- Iris V. Rivero, *Texas Tech University*
- Bhaba R. Sarker, *Louisiana State University*
- James R. Smith, *Tennessee Technological University*
- Donald R. Smith, *Texas A&M University*
- Stan Uryasev, *University of Florida*

I also wish to thank the following individuals for their additional input to the new edition: Kandace Ballard, John Evans, Linda Ann Riley, and Bhaba Sarker who offered numerous comments to improve the presentation of the materials. Thanks also go to Edward Park who read the entire manuscript from a student's point of view and made many constructive comments; Daphne Ku, Seungbae Park, and Wonsuk Kang who helped me develop the Instructor's Manual; Orhan Dengiz who helped me develop the book Website; Holly Stark, my editor, and Scott Disanno, senior managing editor, both at Prentice Hall, who assumed responsibility for the overall project; and Maheswari PonSaravanan at Jouve, India, the project manager, who oversaw the entire book production.

CHAN S. PARK
AUBURN, ALABAMA

CONTENTS

Preface v

PART I UNDERSTANDING MONEY AND ITS MANAGEMENT 1

Chapter 1 Engineering Economic Decisions 2

1.1	The Rational Decision-Making Process	4
1.1.1	How Do We Make Typical Personal Decisions?	4
1.1.2	How Do We Approach an Engineering Design Problem?	7
1.1.3	What Makes Economic Decisions Different from Other Design Decisions?	9
1.2	The Engineer's Role in Business	10
1.2.1	Making Capital-Expenditure Decisions	10
1.2.2	Large-Scale Engineering Economic Decisions	10
1.2.3	Impact of Engineering Projects on Financial Statements	12
1.3	Types of Strategic Engineering Economic Decisions	13
1.3.1	New Products or Product Expansion	14
1.3.2	Equipment and Process Selection	14
1.3.3	Cost Reduction	15
1.3.4	Equipment Replacement	16
1.3.5	Service or Quality Improvement	16
1.4	Fundamental Principles in Engineering Economics	17
	Summary	18
	Self-Test Questions	19
	Problems	19

Chapter 2 Time Value of Money 20

2.1	Interest: The Cost of Money	22
2.1.1	The Time Value of Money	22
2.1.2	Elements of Transactions Involving Interest	24
2.1.3	Methods of Calculating Interest	26
2.2	Economic Equivalence	28
2.2.1	Definition and Simple Calculations	29
2.2.2	Equivalence Calculations Require a Common Time Basis for Comparison	32
2.3	Interest Formulas for Single Cash Flows	33
2.3.1	Compound-Amount Factor	33
2.3.2	Present-Worth Factor	35
2.3.3	Solving for Time and Interest Rates	38

2.4	Uneven-Payment Series	40
2.5	Equal-Payment Series	42
2.5.1	Compound-Amount Factor: Find F , Given A , i , and N	42
2.5.2	Sinking-Fund Factor: Find A , Given F , i , and N	46
2.5.3	Capital-Recovery Factor (Annuity Factor): Find A , Given P , i , and N	48
2.5.4	Present-Worth Factor: Find P , Given A , i , and N	51
2.5.5	Present Value of Perpetuities	56
2.6	Dealing with Gradient Series	58
2.6.1	Handling Linear Gradient Series	58
2.6.2	Handling Geometric Gradient Series	64
2.7	More on Equivalence Calculations	68
	Summary	74
	Self-Test Questions	75
	Problems	79

Chapter 3 Understanding Money Management 94

3.1	Market Interest Rates	96
3.1.1	Nominal Interest Rates	96
3.1.2	Annual Effective Yields	97
3.2	Calculating Effective Interest Rates Based on Payment Periods	100
3.2.1	Discrete Compounding	100
3.2.2	Continuous Compounding	101
3.3	Equivalence Calculations with Effective Interest Rates	103
3.3.1	Compounding Period Equal to Payment Period	103
3.3.2	Compounding Occurs at a Different Rate than That at Which Payments are Made	106
3.4	Debt Management	110
3.4.1	Borrowing with Credit Cards	110
3.4.2	Commercial Loans—Calculating Principal and Interest Payments	113
3.4.3	Comparing Different Financing Options	116
	Summary	121
	Self-Test Questions	123
	Problems	126

Chapter 4 Equivalence Calculations under Inflation 140

4.1	Measure of Inflation	141
4.1.1	Consumer Price Index	142
4.1.2	Producer Price Index	143
4.1.3	Average Inflation Rate	145
4.1.4	General Inflation Rate (\bar{f}) versus Specific Inflation (f_j)	146

4.2	Actual versus Constant Dollars	148
4.2.1	Conversion from Constant to Actual Dollars	149
4.2.2	Conversion from Actual to Constant Dollars	150
4.3	Equivalence Calculations under Inflation	154
4.3.1	Market and Inflation-Free Interest Rates	155
4.3.2	Constant-Dollar Analysis	155
4.3.3	Actual-Dollar Analysis	156
4.3.4	Mixed-Dollar Analysis	160
	Summary	163
	Self-Test Questions	164
	Problems	166

PART 2 EVALUATING BUSINESS AND ENGINEERING ASSETS 173

Chapter 5 Present-Worth Analysis 174

5.1	Loan versus Project Cash Flows	176
5.2	Initial Project Screening Methods	177
5.2.1	Benefits and Flaws of Payback Screening	179
5.2.2	Discounted-Payback Period	180
5.3	Present-Worth Analysis	182
5.3.1	Net-Present-Worth Criterion	182
5.3.2	Guidelines for Selecting a MARR	187
5.3.3	Meaning of Net Present Worth	188
5.3.4	Net Future Worth and Project Balance Diagram	192
5.3.5	Capitalized-Equivalent Method	193
5.4	Methods to Compare Mutually Exclusive Alternatives	195
5.4.1	Doing Nothing Is a Decision Option	196
5.4.2	Service Projects versus Revenue Projects	196
5.4.3	Analysis Period Equals Project Lives	197
5.4.4	Analysis Period Differs from Project Lives	201
	Summary	207
	Self-Test Questions	207
	Problems	210

Chapter 6 Annual-Equivalence Analysis 230

6.1	Annual-Equivalent Worth Criterion	232
6.1.1	Benefits of AE Analysis	236
6.1.2	Capital (Ownership) Costs versus Operating Costs	236
6.2	Applying Annual-Worth Analysis	241
6.2.1	Unit-Profit or Unit-Cost Calculation	241
6.2.2	Make-or-Buy Decision	245

6.3	Comparing Mutually Exclusive Projects	248
6.3.1	Analysis Period Equals Project Lives	248
6.3.2	Analysis Period Differs from Project Lives	253
	Summary	256
	Self-Test Questions	256
	Problems	259

Chapter 7 Rate-of-Return Analysis 276

7.1	Rate of Return	278
7.1.1	Return on Investment	278
7.1.2	Return on Invested Capital	279
7.2	Methods for Finding Rate of Return	280
7.2.1	Simple versus Nonsimple Investments	280
7.2.2	Computational Methods	282
7.3	Internal-Rate-of-Return Criterion	289
7.3.1	Relationship to the PW Analysis	289
7.3.2	Decision Rule for Simple Investments	289
7.3.3	Decision Rule for Nonsimple Investments	293
7.4	Incremental Analysis for Comparing Mutually Exclusive Alternatives	295
7.4.1	Flaws in Project Ranking by IRR	295
7.4.2	Incremental-Investment Analysis	296
7.4.3	Handling Unequal Service Lives	302
	Summary	304
	Self-Test Questions	304
	Problems	308

Chapter 7A Resolution of Multiple Rates of Return 324

7A-1	Net-Investment Test	324
7A-2	The Need for an External Interest Rate	326
7A-3	Calculation of Return on Invested Capital for Mixed Investments	327

Chapter 8 Benefit–Cost Analysis 332

8.1	Evaluation of Public Projects	334
8.1.1	Valuation of Benefits and Costs	335
8.1.2	Users' Benefits	335
8.1.3	Sponsor's Costs	335
8.1.4	Social Discount Rate	336
8.2	Benefit–Cost Analysis	337
8.2.1	Definition of Benefit–Cost Ratio	337
8.2.2	Incremental B/C-Ratio Analysis	340

8.3	Profitability Index	344
8.3.1	Definition of Profitability Index	344
8.3.2	Incremental PI Ratio for Mutually Exclusive Alternatives	346
8.4	Highway Benefit–Cost Analysis	348
8.4.1	Define the Base Case and the Proposed Alternatives	348
8.4.2	Highway User Benefits	349
8.4.3	Sponsors’ Costs	349
8.4.4	Illustrating Case Example	350
	Summary	354
	Self-Test Questions	354
	Problems	357

PART 3 DEVELOPMENT OF PROJECT CASH FLOWS 365

Chapter 9 Accounting for Depreciation and Income Taxes 366

9.1	Accounting Depreciation	368
9.1.1	Depreciable Property	368
9.1.2	Cost Basis	369
9.1.3	Useful Life and Salvage Value	370
9.1.4	Depreciation Methods: Book and Tax Depreciation	370
9.2	Book Depreciation Methods	372
9.2.1	Straight-Line Method	372
9.2.2	Declining-Balance Method	374
9.2.3	Units-of-Production Method	378
9.3	Tax Depreciation Methods	379
9.3.1	MACRS Recovery Periods	379
9.3.2	MACRS Depreciation: Personal Property	380
9.3.3	MACRS Depreciation: Real Property	383
9.4	Corporate Taxes	385
9.4.1	How to Determine “Accounting Profit”	385
9.4.2	U.S. Corporate Income Tax Rates	387
9.4.3	Gain Taxes on Asset Disposals	389
	Summary	393
	Self-Test Questions	394
	Problems	396

Chapter 10 Project Cash-Flow Analysis 408

10.1	Understanding Project Cost Elements	410
10.1.1	Classifying Costs for Manufacturing Environments	410
10.1.2	Classifying Costs for Financial Statements	412
10.1.3	Classifying Costs for Predicting Cost Behavior	413
10.2	Why Do We Need to Use Cash Flows in Economic Analysis?	417

10.3	Income-Tax Rate to Be Used in Project Evaluation	418
10.4	Incremental Cash Flows from Undertaking a Project	421
10.4.1	Operating Activities	421
10.4.2	Investing Activities	424
10.4.3	Financing Activities	425
10.5	Developing Project Cash Flow Statements	425
10.5.1	When Projects Require Only Operating and Investing Activities	425
10.5.2	When Projects Are Financed with Borrowed Funds	428
10.6	Effects of Inflation on Project Cash Flows	431
10.6.1	Depreciation Allowance under Inflation	431
10.6.2	Handling Multiple Inflation Rates	435
	Summary	437
	Self-Test Questions	438
	Problems	441

Chapter 11 Handling Project Uncertainty 462

11.1	Origins of Project Risk	465
11.2	Methods of Describing Project Risk	465
11.2.1	Sensitivity Analysis	465
11.2.2	Sensitivity Analysis for Mutually Exclusive Alternatives	470
11.2.3	Break-Even Analysis	473
11.2.4	Scenario Analysis	474
11.3	Probabilistic Cash Flow Analysis	477
11.3.1	Including Risk in Investment Evaluation	478
11.3.2	Aggregating Risk over Time	479
11.3.3	Estimating Risky Cash Flows	482
11.4	Considering the Project Risk by Discount Rate	486
11.4.1	Determining the Company Cost of Capital	486
11.4.2	Project Cost of Capital: Risk-Adjusted Discount Rate Approach	491
	Summary	493
	Self-Test Questions	494
	Problems	496

PART 4 SPECIAL TOPICS IN ENGINEERING ECONOMICS 511

Chapter 12 Replacement Decisions 512

12.1	Replacement-Analysis Fundamentals	514
12.1.1	Basic Concepts and Terminology	515
12.1.2	Approaches for Comparing Defender and Challenger	517
12.2	Economic Service Life	521

12.3	Replacement Analysis When the Required Service Period Is Long	527
12.3.1	Required Assumptions and Decision Frameworks	527
12.3.2	Handling Unequal Service Life Problems in Replacement Analysis	528
12.3.3	Replacement Strategies under the Infinite Planning Horizon	528
12.4	Replacement Analysis with Tax Considerations	534
	Summary	541
	Self-Test Questions	542
	Problems	543

Chapter 13 Understanding Financial Statements 556

13.1	Accounting: The Basis of Decision Making	558
13.2	Financial Status for Businesses	559
13.2.1	The Balance Sheet	561
13.2.2	The Income Statement	566
13.2.3	The Cash-Flow Statement	568
13.3	Using Ratios to Make Business Decisions	574
13.3.1	Debt Management Analysis	574
13.3.2	Liquidity Analysis	577
13.3.3	Asset Management Analysis	578
13.3.4	Profitability Analysis	579
13.3.5	Market-Value Analysis	581
13.3.6	Limitations of Financial Ratios in Business Decisions	583
13.3.7	Where We Get the Most Up-to-Date Financial Information	585
13.4	Principle of Investing in Financial Assets	585
13.4.1	Trade-Off between Risk and Reward	585
13.4.2	Broader Diversification Reduces Risk	585
13.4.3	Broader Diversification Increases Expected Return	587
	Summary	589
	Self-Test Questions	590
	Problems	594

Appendix A Answers to the Self-Test Questions 603

Appendix B Interest Factors for Discrete Compounding 631

Appendix C How to Read the Cumulative Standardized Normal Distribution Function 661

Index 664

