

Contents

Preface xi

Chapter 1

Foundations of Engineering Economy 1

- Purpose and Learning Outcomes 2
- 1.1 What is Engineering Economy? 3
- 1.2 Performing an Engineering Economy Study 3
- 1.3 Interest Rate, Rate of Return, and MARR 5
- 1.4 Equivalence 8
- 1.5 Simple and Compound Interest 9
- 1.6 Terminology and Symbols 14
- 1.7 Cash Flows: Their Estimation and Diagramming 16
- 1.8 Introduction to Spreadsheet and Calculator Functions 20
- 1.9 Ethics and Economic Decisions 23
- Summary 28
- Problems 28
- Additional Problems and FE Exam
- Review Questions 32

Chapter 2

Factors: How Time and Interest Affect Money 33

- Purpose and Learning Outcomes 34
- 2.1 Single-Payment Formulas (F/P and P/F) 35
- 2.2 Uniform Series Formulas (P/A , A/P , A/F , F/A) 40
- 2.3 Gradient Formulas 44
- 2.4 Calculations for Cash Flows That are Shifted 47
- 2.5 Using Spreadsheets and Calculators 52
- Summary 58

- Problems 58
- Additional Problems and FE Exam
- Review Questions 68

Chapter 3

Nominal and Effective Interest Rates 71

- Purpose and Learning Outcomes 72
- 3.1 Nominal and Effective Interest Rate Statements 73
- 3.2 Effective Interest Rate Formulation 75
- 3.3 Reconciling Compounding Periods and Payment Periods 77
- 3.4 Equivalence Calculations Involving Only Single-Amount Factors 78
- 3.5 Equivalence Calculations Involving Series with $PP \geq CP$ 80
- 3.6 Equivalence Calculations Involving Series with $PP < CP$ 82
- 3.7 Using Spreadsheets for Effective Interest Rate Computations 84
- Summary 86
- Problems 87
- Additional Problems and FE Exam
- Review Questions 92

Chapter 4

Present Worth Analysis 94

- Purpose and Learning Outcomes 95
- 4.1 Formulating Alternatives 96
- 4.2 Present Worth Analysis of Equal-Life Alternatives 98
- 4.3 Present Worth Analysis of Different-Life Alternatives 100
- 4.4 Capitalized Cost Analysis 104
- 4.5 Evaluation of Independent Projects 108

4.6 Using Spreadsheets for PW Analysis 110

Summary 112

Problems 113

Additional Problems and FE Exam

Review Questions 121

Chapter 5**Annual Worth Analysis 123**

Purpose and Learning Outcomes 124

5.1 AW Value Calculations 125**5.2 Evaluating Alternatives Based on Annual Worth 127****5.3 AW of a Long-Life or Infinite-Life Investment 130****5.4 Using Spreadsheets for AW Analysis 132**

Summary 134

Problems 135

Additional Problems and FE Exam

Review Questions 139

Chapter 6**Rate of Return Analysis 141**

Purpose and Learning Outcomes 142

6.1 Interpretation of ROR Values 143**6.2 ROR Calculation 145****6.3 Cautions when Using the ROR Method 148****6.4 Understanding Incremental ROR Analysis 148****6.5 ROR Evaluation of Two or More Mutually Exclusive Alternatives 152****6.6 Multiple ROR Values 156****6.7 Techniques to Remove Multiple ROR Values 160****6.8 Using Spreadsheets and Calculators to Determine ROR Values 166**

Summary 170

Problems 170

Additional Problems and FE Exam

Review Questions 178

Chapter 7**Benefit/Cost Analysis and Public Sector Projects 181**

Purpose and Learning Outcomes 182

7.1 Public Sector Projects: Description and Ethics 183**7.2 Benefit/Cost Analysis of a Single Project 188****7.3 Incremental B/C Evaluation of Two or More Alternatives 191****7.4 Using Spreadsheets for B/C Analysis 197**

Summary 199

Problems 199

Additional Problems and FE Exam

Review Questions 204

Chapter 8**Breakeven, Sensitivity, and Payback Analysis 206**

Purpose and Learning Outcomes 207

8.1 Breakeven Analysis for a Single Project 208**8.2 Breakeven Analysis between Two Alternatives 213****8.3 Sensitivity Analysis for Variation in Estimates 216****8.4 Sensitivity Analysis of Multiple Parameters for Multiple Alternatives 221****8.5 Payback Period Analysis 223****8.6 Using Spreadsheets for Sensitivity or Breakeven Analysis 225**

Summary 230

Problems 231

Additional Problems and FE Exam

Review Questions 238

Chapter 9**Replacement and Retention Decisions 241**

Purpose and Learning Outcomes 242

9.1 Basics of a Replacement Study 243**9.2 Economic Service Life 244**

- 9.3 Performing a Replacement Study 246**
- 9.4 Defender Replacement Value 250**
- 9.5 Replacement Study Over a Specified Study Period 250**
- 9.6 Using Spreadsheets for a Replacement Study 254**
 - Summary 257
 - Problems 257
 - Additional Problems and FE Exam
 - Review Questions 262

Chapter 10

Effects of Inflation 264

- Purpose and Learning Outcomes 265
- 10.1 Understanding the Impact of Inflation 266**
- 10.2 PW Calculations Adjusted for Inflation 269**
- 10.3 FW Calculations Adjusted for Inflation 274**
- 10.4 AW Calculations Adjusted for Inflation 278**
- 10.5 Using Spreadsheets to Adjust for Inflation 279**
 - Summary 282
 - Problems 283
 - Additional Problems and FE Exam
 - Review Questions 287

Chapter 11

Estimating Costs 289

- Purpose and Learning Outcomes 290
- 11.1 How Cost Estimates are Made 291**
- 11.2 Unit Method 294**
- 11.3 Cost Indexes 296**
- 11.4 Cost-Estimating Relationships: Cost-Capacity Equations 299**
- 11.5 Cost-Estimating Relationships: Factor Method 301**
- 11.6 Cost-Estimating Relationships: Learning Curve 303**
- 11.7 Indirect Cost Estimation and Allocation 305**
 - Summary 311

- Problems 312
- Additional Problems and FE Exam
- Review Questions 315

Chapter 12

Depreciation Methods 317

- Purpose and Learning Outcomes 318
- 12.1 Depreciation Terminology 319**
- 12.2 Straight Line (SL) Depreciation 321**
- 12.3 Declining Balance Depreciation 323**
- 12.4 Modified Accelerated Cost Recovery System (MACRS) 325**
- 12.5 Tax Depreciation System in Canada 329**
- 12.6 Switching Between Classical Methods; Relation to MACRS Rates 330**
- 12.7 Depletion Methods 332**
- 12.8 Using Spreadsheets for Depreciation Computations 334**
 - Summary 337
 - Problems 338
 - Additional Problems and FE Exam
 - Review Questions 342

Chapter 13

After-Tax Economic Analysis 344

- Purpose and Learning Outcomes 345
- 13.1 Income Tax Terminology and Relations 346**
- 13.2 Before-Tax and After-Tax Alternative Evaluation 349**
- 13.3 How Depreciation Can Affect an After-Tax Study 352**
- 13.4 After-Tax Replacement Study 358**
- 13.5 Capital Funds and the Cost of Capital 360**
- 13.6 Using Spreadsheets for After-Tax Evaluation 364**
- 13.7 After-Tax Value-Added Analysis 367**
 - Summary 370
 - Problems 370
 - Additional Problems and FE Exam
 - Review Questions 376

Chapter 14

Alternative Evaluation Considering Multiple Attributes and Risk 378

Purpose and Learning Outcomes 379

14.1 Multiple Attribute Analysis 380

14.2 Economic Evaluation with Risk Considered 385

14.3 Alternative Evaluation Using Sampling and Simulation 394

Summary 398

Problems 398

Additional Problems 401

Appendix A

Using Spreadsheets and Microsoft Excel® 403

A.1 Introduction to Using Excel 403

A.2 Organization (Layout) of the Spreadsheet 406

A.3 Excel Functions Useful in Engineering Economy (alphabetical order) 407

A.4 Goal Seek—A Spreadsheet Tool for Breakeven and Sensitivity Analyses 416

A.5 Error Messages 417

Appendix B

Accounting Reports and Business Ratios 418

B.1 The Balance Sheet 418

B.2 Income Statement and Cost of Goods Sold Statement 419

B.3 Business Ratios 421

Appendix C

Final Answers to Selected Problems 425

Reference Materials 437

Interest Factor Tables 439

Index 465