

CONTENTS

Preface to Seventh Edition xiii

LEARNING STAGE 1

THE FUNDAMENTALS

Chapter 1	Foundations of Engineering Economy	2
1.1	Engineering Economics: Description and Role in Decision Making	3
1.2	Performing an Engineering Economy Study	4
1.3	Professional Ethics and Economic Decisions	7
1.4	Interest Rate and Rate of Return	10
1.5	Terminology and Symbols	13
1.6	Cash Flows: Estimation and Diagramming	15
1.7	Economic Equivalence	19
1.8	Simple and Compound Interest	21
1.9	Minimum Attractive Rate of Return	25
1.10	Introduction to Spreadsheet Use	27
	Chapter Summary	31
	Problems	31
	Additional Problems and FE Exam Review Questions	35
	Case Study—Renewable Energy Sources for Electricity Generation	36
	Case Study—Refrigerator Shells	37
Chapter 2	Factors: How Time and Interest Affect Money	38
PE	Progressive Example—The Cement Factory Case	39
2.1	Single-Amount Factors (F/P and P/F)	39
2.2	Uniform-Series Present Worth Factor and Capital Recovery Factor (P/A and A/P)	43
2.3	Sinking Fund Factor and Uniform-Series Compound Amount Factor (A/F and F/A)	46
2.4	Factor Values for Untabulated i or n Values	48
2.5	Arithmetic Gradient Factors (P/G and A/G)	50
2.6	Geometric Gradient Series Factors	58
2.7	Determining i or n for Known Cash Flow Values	61
	Chapter Summary	64
	Problems	64
	Additional Problems and FE Exam Review Questions	69
	Case Study—Time Marches On; So Does the Interest Rate	70
Chapter 3	Combining Factors and Spreadsheet Functions	72
3.1	Calculations for Uniform Series That Are Shifted	73
3.2	Calculations Involving Uniform Series and Randomly Placed Single Amounts	76
3.3	Calculations for Shifted Gradients	80
	Chapter Summary	86
	Problems	86
	Additional Problems and FE Exam Review Questions	92
	Case Study—Preserving Land for Public Use	93
Chapter 4	Nominal and Effective Interest Rates	94
PE	Progressive Example—The Credit Card Offer Case	95
4.1	Nominal and Effective Interest Rate Statements	96
4.2	Effective Annual Interest Rates	99
4.3	Effective Interest Rates for Any Time Period	105
4.4	Equivalence Relations: Payment Period and Compounding Period	106
4.5	Equivalence Relations: Single Amounts with $PP \geq CP$	107

4.6	Equivalence Relations: Series with $PP \geq CP$	109
4.7	Equivalence Relations: Single Amounts and Series with $PP < CP$	112
4.8	Effective Interest Rate for Continuous Compounding	114
4.9	Interest Rates That Vary over Time	116
	Chapter Summary	117
	Problems	118
	Additional Problems and FE Exam Review Questions	122
	Case Study—Is Owning a Home a Net Gain or Net Loss over Time?	124

**LEARNING
STAGE 2**
BASIC ANALYSIS TOOLS

Chapter 5	Present Worth Analysis	128
	PE Progressive Example—Water for Semiconductor Manufacturing Case	129
5.1	Formulating Alternatives	129
5.2	Present Worth Analysis of Equal-Life Alternatives	131
5.3	Present Worth Analysis of Different-Life Alternatives	133
5.4	Future Worth Analysis	137
5.5	Capitalized Cost Analysis	138
	Chapter Summary	142
	Problems	142
	Additional Problems and FE Exam Review Questions	147
	Case Study—Comparing Social Security Benefits	149
Chapter 6	Annual Worth Analysis	150
6.1	Advantages and Uses of Annual Worth Analysis	151
6.2	Calculation of Capital Recovery and AW Values	153
6.3	Evaluating Alternatives by Annual Worth Analysis	155
6.4	AW of a Permanent Investment	157
6.5	Life-Cycle Cost Analysis	160
	Chapter Summary	164
	Problems	164
	Additional Problems and FE Exam Review Questions	169
	Case Study—The Changing Scene of an Annual Worth Analysis	171
Chapter 7	Rate of Return Analysis: One Project	172
7.1	Interpretation of a Rate of Return Value	173
7.2	Rate of Return Calculation Using a PW or AW Relation	175
7.3	Special Considerations When Using the ROR Method	179
7.4	Multiple Rate of Return Values	180
7.5	Techniques to Remove Multiple Rates of Return	184
7.6	Rate of Return of a Bond Investment	190
	Chapter Summary	193
	Problems	193
	Additional Problems and FE Exam Review Questions	198
	Case Study—Developing and Selling an Innovative Idea	200
Chapter 8	Rate of Return Analysis: Multiple Alternatives	202
8.1	Why Incremental Analysis Is Necessary	203
8.2	Calculation of Incremental Cash Flows for ROR Analysis	203
8.3	Interpretation of Rate of Return on the Extra Investment	206
8.4	Rate of Return Evaluation Using PW: Incremental and Breakeven	207
8.5	Rate of Return Evaluation Using AW	213
8.6	Incremental ROR Analysis of Multiple Alternatives	214

8.7	All-in-One Spreadsheet Analysis (Optional)	218
	Chapter Summary	219
	Problems	220
	Additional Problems and FE Exam Review Questions	225
	Case Study —ROR Analysis with Estimated Lives That Vary	226
	Case Study —How a New Engineering Graduate Can Help His Father	227

Chapter 9 Benefit/Cost Analysis and Public Sector Economics 228

PE	Progressive Example—Water Treatment Facility #3 Case	229
9.1	Public Sector Projects	230
9.2	Benefit/Cost Analysis of a Single Project	235
9.3	Alternative Selection Using Incremental B/C Analysis	238
9.4	Incremental B/C Analysis of Multiple, Mutually Exclusive Alternatives	242
9.5	Service Sector Projects and Cost-Effectiveness Analysis	246
9.6	Ethical Considerations in the Public Sector	250
	Chapter Summary	251
	Problems	252
	Additional Problems and FE Exam Review Questions	258
	Case Study —Comparing B/C Analysis and CEA of Traffic Accident Reduction	259

LEARNING STAGE 2

EPILOGUE: SELECTING THE BASIC ANALYSIS TOOL

LEARNING STAGE 3

MAKING BETTER DECISIONS

Chapter 10 Project Financing and Noneconomic Attributes 266

10.1	MARR Relative to the Cost of Capital	267
10.2	Debt-Equity Mix and Weighted Average Cost of Capital	269
10.3	Determination of the Cost of Debt Capital	271
10.4	Determination of the Cost of Equity Capital and the MARR	273
10.5	Effect of Debt-Equity Mix on Investment Risk	275
10.6	Multiple-Attribute Analysis: Identification and Importance of Each Attribute	278
10.7	Evaluation Measure for Multiple Attributes	282
	Chapter Summary	283
	Problems	284
	Additional Problems and FE Exam Review Questions	289
	Case Study —Which Is Better—Debt or Equity Financing?	290

Chapter 11 Replacement and Retention Decisions 292

PE	Progressive Example—Keep or Replace the Kiln Case	293
11.1	Basics of a Replacement Study	294
11.2	Economic Service Life	296
11.3	Performing a Replacement Study	302
11.4	Additional Considerations in a Replacement Study	306
11.5	Replacement Study over a Specified Study Period	307
11.6	Replacement Value	312
	Chapter Summary	312
	Problems	313
	Additional Problems and FE Exam Review Questions	319
	Case Study —Will the Correct ESL Please Stand?	321

Chapter 12	Independent Projects with Budget Limitation	322
12.1	An Overview of Capital Rationing among Projects	323
12.2	Capital Rationing Using PW Analysis of Equal-Life Projects	325
12.3	Capital Rationing Using PW Analysis of Unequal-Life Projects	327
12.4	Capital Budgeting Problem Formulation Using Linear Programming	329
12.5	Additional Project Ranking Measures	332
	Chapter Summary	334
	Problems	334
	Additional Problems and FE Exam Review Questions	338
Chapter 13	Breakeven and Payback Analysis	340
13.1	Breakeven Analysis for a Single Project	341
13.2	Breakeven Analysis Between Two Alternatives	345
13.3	Payback Analysis	348
13.4	More Breakeven and Payback Analysis on Spreadsheets	352
	Chapter Summary	355
	Problems	355
	Additional Problems and FE Exam Review Questions	361
	Case Study—Water Treatment Plant Process Costs	363

**LEARNING
STAGE 4**
ROUNDING OUT THE STUDY

Chapter 14	Effects of Inflation	366
14.1	Understanding the Impact of Inflation	367
14.2	Present Worth Calculations Adjusted for Inflation	369
14.3	Future Worth Calculations Adjusted for Inflation	374
14.4	Capital Recovery Calculations Adjusted for Inflation	377
	Chapter Summary	378
	Problems	379
	Additional Problems and FE Exam Review Questions	384
	Case Study—Inflation versus Stock and Bond Investments	385
Chapter 15	Cost Estimation and Indirect Cost Allocation	386
15.1	Understanding How Cost Estimation Is Accomplished	387
15.2	Unit Method	390
15.3	Cost Indexes	391
15.4	Cost Estimating Relationships: Cost-Capacity Equations	394
15.5	Cost Estimating Relationships: Factor Method	395
15.6	Traditional Indirect Cost Rates and Allocation	397
15.7	Activity-Based Costing (ABC) for Indirect Costs	401
15.8	Making Estimates and Maintaining Ethical Practices	403
	Chapter Summary	404
	Problems	404
	Additional Problems and FE Exam Review Questions	410
	Case Study—Indirect Cost Analysis of Medical Equipment Manufacturing Costs	411
	Case Study—Deceptive Acts Can Get You in Trouble	412
Chapter 16	Depreciation Methods	414
16.1	Depreciation Terminology	415
16.2	Straight Line (SL) Depreciation	418
16.3	Declining Balance (DB) and Double Declining Balance (DDB) Depreciation	419
16.4	Modified Accelerated Cost Recovery System (MACRS)	422
16.5	Determining the MACRS Recovery Period	426

16.6	Depletion Methods	427
	Chapter Summary	429
	Appendix	430
16A.1	Sum-of-Year Digits (SYD) and Unit-of-Production (UOP) Depreciation	430
16A.2	Switching between Depreciation Methods	432
16A.3	Determination of MACRS Rates	435
	Problems	438
	Additional Problems and FE Exam Review Questions	442
	Appendix Problems	443
Chapter 17	After-Tax Economic Analysis	444
17.1	Income Tax Terminology and Basic Relations	445
17.2	Calculation of Cash Flow after Taxes	448
17.3	Effect on Taxes of Different Depreciation Methods and Recovery Periods	450
17.4	Depreciation Recapture and Capital Gains (Losses)	453
17.5	After-Tax Evaluation	456
17.6	After-Tax Replacement Study	462
17.7	After-Tax Value-Added Analysis	465
17.8	After-Tax Analysis for International Projects	468
17.9	Value-Added Tax	470
	Chapter Summary	472
	Problems	473
	Additional Problems and FE Exam Review Questions	481
	Case Study—After-Tax Analysis for Business Expansion	482
Chapter 18	Sensitivity Analysis and Staged Decisions	484
18.1	Determining Sensitivity to Parameter Variation	485
18.2	Sensitivity Analysis Using Three Estimates	490
18.3	Estimate Variability and the Expected Value	491
18.4	Expected Value Computations for Alternatives	492
18.5	Staged Evaluation of Alternatives Using a Decision Tree	494
18.6	Real Options in Engineering Economics	498
	Chapter Summary	503
	Problems	503
	Additional Problems and FE Exam Review Questions	509
	Case Study—Sensitivity to the Economic Environment	510
	Case Study—Sensitivity Analysis of Public Sector Projects—Water Supply Plans	511
Chapter 19	More on Variation and Decision Making under Risk	514
19.1	Interpretation of Certainty, Risk, and Uncertainty	515
19.2	Elements Important to Decision Making under Risk	518
19.3	Random Samples	523
19.4	Expected Value and Standard Deviation	526
19.5	Monte Carlo Sampling and Simulation Analysis	533
	Chapter Summary	540
	Problems	540
	Additional Problems and FE Exam Review Questions	543
	Case Study—Using Simulation and Three-Estimate Sensitivity Analysis	544
Appendix A	Using Spreadsheets and Microsoft Excel®	547
A.1	Introduction to Using Excel	547
A.2	Organization (Layout) of the Spreadsheet	549
A.3	Excel Functions Important to Engineering Economy	550
A.4	Goal Seek—A Tool for Breakeven and Sensitivity Analysis	558
A.5	Solver—An Optimizing Tool for Capital Budgeting, Breakeven, and Sensitivity Analysis	559
A.6	Error Messages	560

Appendix B	Basics of Accounting Reports and Business Ratios	561
B.1	The Balance Sheet	561
B.2	Income Statement and Cost of Goods Sold Statement	562
B.3	Business Ratios	563
Appendix C	Code of Ethics for Engineers	566
Appendix D	Alternate Methods for Equivalence Calculations	569
D.1	Using Programmable Calculators	569
D.2	Using the Summation of a Geometric Series	570
Appendix E	Glossary of Concepts and Terms	573
E.1	Important Concepts and Guidelines	573
E.2	Symbols and Terms	576
<i>Reference Materials</i>	<i>579</i>	
<i>Factor Tables</i>	<i>581</i>	
<i>Credit</i>	<i>610</i>	
<i>Index</i>	<i>611</i>	