

GE403

Engineering Economy

First Semester 1439-40H

Course Objectives

Course objectives are for you to

- be able to prepare economic justifications for engineering proposals
- be able to manage personal finances and make wise investment decisions
- be able to evaluate economic justifications performed by others

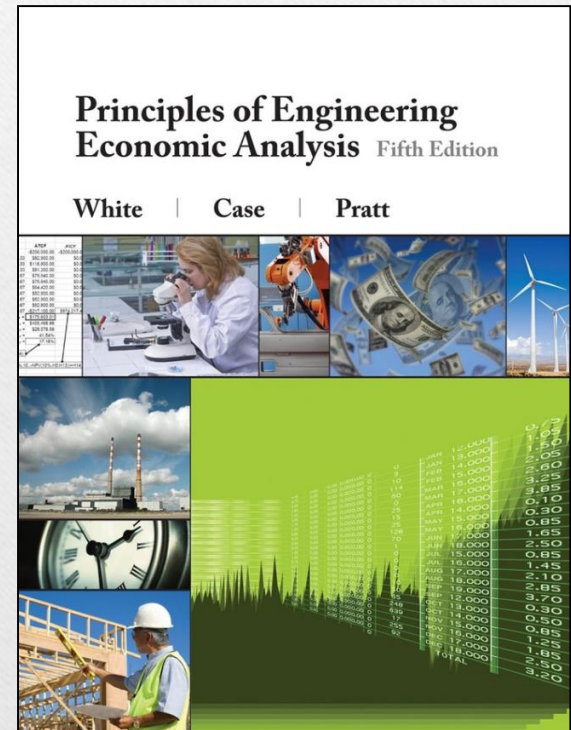
Course Objectives

Other course objectives are for you to

- be comfortable using financial language
- be aware of tradeoffs involving expenses and capital costs under tax and inflation conditions
- be familiar with advanced techniques of modeling decision problems under risk and uncertainty conditions
- have fun!

Textbook

Principles of Engineering Economic Analysis, J. A. White, K. E. Case, and D. B. Pratt, 5th edition, John Wiley & Sons, Inc., 2009.



Course Topics

KING SAUD UNIVERSITY - College of Engineering
 GE 403: Engineering Economy (First Semester 1439-1440 H, 2018-2019 G)
 INSTRUCTORS: Prof. A. Al-Suhaibani, Dr. Mark Lee, Dr. Saif Alarifi, Dr. Fahad Bin Wo'lah
 TEXT: White, Case, and Pratt, "Principles of Engineering Economic Analysis," 5th Edition.

Chapter	Topics	Homework
1	Introduction to Engineering Economic Analysis: Principles of Engineering Economic Analysis, Economic Analysis Techniques. Sections 1-2→1-4	8, 9, 10
2	<i>Time Value Of Money</i> : Cash Flow Diagrams, Simple Interest Calculations, Compound Interest Calculations, Multiple Compounding Periods in a year and Continuous Compound Interest Calculations. Sections: 2-1→2-6, 2-A.	6, 8, 9, 13, 15, 16, 24, 32, 56, 90, 98, 130, 156, 164, 172.
3	<i>Equivalence and Indifference</i> . Section 3-7, 3-9	40, 41, 42, 43, 44, 45, 58, 60
4	<i>Comparison of Alternatives</i> ., Choosing Planning Horizons, Sections: 4-1, 4-2	4, 5, 6
5	Measure of Worth: <i>Present Worth Analysis</i> : Single Alternative, Multiple Alternatives, One shot investment, Sections: 5-3, 5-4, 5-5 <i>Payback Period</i> : Single Alternative, Multiple Alternatives, Section: 5-6 <i>Capitalized Worth</i> : Single Alternative, Multiple Alternatives, Sections: 5-8, 5-9	CH5: 9, 10, 12, 13, 25, 27, 61, 62, 65, 66, 72, 74
6	<i>Future Worth Analysis</i> : Single Alternative, Multiple Alternatives, One shot investment, Sections: 6-2, 6-3, 6-5	CH6: 4, 7, 9, 18, 31, 32, 36, 67, 68
7	<i>Annual Worth Analysis</i> : Single Alternative, Multiple Alternatives, Least Common Multiple of Lives Assumption, Sections: 7-2, 7-3, 7-4	CH7: 4, 5, 8, 23, 24, 25, 28, 51, 53, 60, 61, 63
8	<i>Capital Recovery Cost</i> : Section 7-6 <i>Internal Rate of Return</i> : Single Alternative, Multiple Alternatives, Sections: 8-2, 8-3 <i>External Rate of Return</i> : Single Alternative, Multiple Alternatives, Sections: 8-4, 8-5 <i>Analyzing Alternatives With no Positive Cash Flow</i> : Section 8-6	CH8: 3, 5, 8, 15, 34, 51, 53, 54, 65, 68, 70
9	<i>Depreciation</i> Sections: 9.1, 9.3, 9.4, 9.5, 9.A	9,10,11,12,13,14
11	<i>Replacement Analysis</i> : Sections 11-1, 11-2, 11-2-1, 11-3, 11-3-1	4, 5, 7
14	<i>Economic Analysis of Public Projects</i> . Sections: 14-1 to 14-8	6, 8, 9, 13, 15
16	<i>Cost Terminology</i> : Life Cycle Viewpoint, Past/Future Viewpoint, Manufacturing Cost Structure Viewpoint, Fixed/Variable Viewpoint and Average/Marginal Viewpoint. Section 16-2	3, 4, 6, 10, 12

Grade Distribution

Quizzes		10% of final grade
1 st Midterm (6:00 - 7:30 PM)	Tuesday 29/01/1440 (09/10/2018)	25% of final grade
2 nd Midterm (5:45 - 7:15 PM)	Monday 11/03/1440 (19/11/2018)	25% of final grade
Final Exam	To be determined by the faculty registrar	40% of final grade

Grade Distribution

Quizzes	Weekly (Given by TA)	10%
1st Midterm Exam	Tuesday 29/01/1440 (09/10/2018) (6:00 - 7:30 PM)	25%
2nd Midterm Exam	Monday 11/03/1440 (19/11/2018) (5:45 - 7:15 PM)	25%
Final Exam	To be allocated by the faculty	40%

Instructor Details

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Chapter 1

Engineering Economic Analysis

Engineering economic analysis: using a combination of quantitative and qualitative techniques to analyze *economic differences* among engineering design alternatives in selecting the preferred design

What Is Included in Chapter 1

1. The importance of the time value of money (TVOM)
2. Four discounted cash flow rules
3. Ten principles of engineering economic analysis
4. A 7-step approach for performing engineering economic analyses

Fundamental Concept

Money has a time value

Time Value of Money

- Would you rather receive \$1000 today or \$1000 a year from today?
- Would you rather receive \$1000 today or \$1050 a year from today?
- Would you rather receive \$1000 today or \$1100 a year from today?
- Would you rather receive \$1000 today or \$1500 a year from today?
- Would you rather receive \$1000 today or \$2000 a year from today?
- Would you rather receive \$1000 today or \$5000 a year from today?
- Would you rather receive \$1000 today or \$10,000 a year from today?
- Would you rather receive \$1000 today or \$100,000 a year from today?

Time Value of Money

- ❑ Regardless of the value of inflation, money has a time value due to its “earning power”
- ❑ Suppose you arrive in a city by airplane and need a car
 - **you can buy a car**
 - **you can rent a car**
- ❑ Suppose you arrive in a city and need a place to stay
 - **you can buy a house or flat**
 - **you can rent a house, apartment, or hotel room**
- ❑ Suppose you arrive in a city and need money
 - **you can rent money from a business or person**

What Is Included in Chapter 1

1. The importance of the time value of money (TVOM)
2. Four discounted cash flow rules
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Four Discounted Cash Flow Rules

1. Money has a *time value*
2. Money cannot be *added or subtracted* unless it occurs at the *same point(s) in time*
3. To move money *forward* one time unit, *multiply by one plus the discount or interest rate*
4. To move money *backward* one time unit, *divide by one plus the discount or interest rate*

What Is Included in Chapter 1

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Principles of Engineering Economic Analysis

1. Money has a time value
2. Make investments that are economically justified

“If you need a new machine and don’t buy it, you pay for it without ever getting it.”

Henry Ford

Principles of Engineering Economic Analysis

3. Choose the mutually exclusive investment alternative that *maximizes economic worth*
4. Two investment alternatives are *equivalent* if they have the same *economic worth*
5. Marginal *revenue* must *exceed* marginal *cost*
6. Continue to invest as long as each additional increment of investment yields a *return* that is greater than the *investor's* TVOM

“The object of management is not necessarily the highest rate of return on capital, but ... to assure profit with each increment of volume that will at least equal the economic cost of additional capital required.”

Donaldson Brown
Chief Financial Officer
General Motor
1924

Principles of Engineering Economic Analysis

7. Consider only differences in cash flows among investment alternatives
8. Compare investment alternatives over a common period of time
9. *Risks and returns tend to be positively correlated*
10. Past costs are irrelevant in engineering economic analyses, unless they *impact future costs*

What Is Included in Chapter 1

1. The importance of the time value of money (TVOM)
2. Four discounted cash flow rules
3. Ten principles of engineering economic analysis
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Economic Justification

Seven Questions to Answer

1. What investment alternatives are available?
2. What is the length of time over which the decision is to be made?
3. What TVOM will be used to move monies forward and/or backward in time?
4. What are the best estimates of the cash flows for each alternative?
5. Which investment alternative seems best, based on the economic criterion chosen?
6. How sensitive is the decision to changes or errors in the estimates used in the analysis?
7. Which investment is recommended?

Systematic Economic Analysis Technique (SEAT)

Seven-Step Procedure

1. Identify the investment alternatives
2. Define the planning horizon
3. Specify the discount rate
4. Estimate the cash flows
5. Compare the alternatives
6. Perform supplementary analyses
7. Select the preferred alternative

Step 1: Identify the Feasible Alternatives

- ❑ Most important step!
- ❑ Consider a range of alternatives
- ❑ Beware the “Do Nothing” alternative
- ❑ Be objective!
- ❑ Impact of “size gates”
- ❑ “Design the whole, justify the whole, and implement the parts”

Example 1.5

A firm is considering three investment proposals (A, B, & C). A requires \$1M investment, B requires \$2.5M, and C requires \$3M.

The firm has \$4.5M to invest. C is contingent on A; B and C are mutually exclusive. The “do nothing” alternative is not feasible.

Form the set of mutually exclusive investment alternatives that exists.

Example 1.5 : Forming Investment Alternatives from Investment Proposals

ALT	Proposals			Comments
	x_A	x_B	x_C	
1	0	0	0	
2	0	0	1	
3	0	1	0	
4	0	1	1	
5	1	0	0	
6	1	0	1	
7	1	1	0	
8	1	1	1	

Example 1.5 : Forming Investment Alternatives from Investment Proposals

ALT	Proposals			Comments
	x_A	x_B	x_C	
1	0	0	0	"Do nothing" not feasible
2	0	0	1	Violates contingency
3	0	1	0	Feasible
4	0	1	1	Mutually exclusive
5	1	0	0	Feasible
6	1	0	1	Feasible
7	1	1	0	Feasible
8	1	1	1	Violates multiple constraints
Four alternatives: {B}, {A}, {A,C}, {A,B}				

Step 2: Define the Planning Horizon*

- ❑ The width of the window
- ❑ U.S. < 5 yrs; Japan > 15 yrs
- ❑ Planning horizon vs. working life vs. depreciable life
- ❑ Standard planning horizons
- ❑ Impact of too short a planning horizon
- ❑ Impact of too long a planning horizon

Step 3: Specify the Discount Rate*

- ❑ Hurdle rate, interest rate, return on investment (ROI), minimum attractive rate of return (MARR)
- ❑ Money has a time value!
- ❑ Opportunity cost for money
- ❑ U.S. – double-digit rates
- ❑ Japan – single-digit rates

Step 4: Estimate the Cash Flows*

- Examples of cash flows
- Depreciation is not a cash flow
- Annual cash flows
- “Best estimates”
- Tangibles and intangibles
- Future estimates, not past estimates
- Costs and revenues
- Incremental cash flows
- Don't forget the competition!

Step 5: Compare the Investment Alternatives

- ❑ Present worth method (PW) (Chapter 5)
- ❑ Capitalized worth method (CW) (Chapter 5)
- ❑ Discounted payback period method (DPBP) (Chapter 5)
- ❑ Payback period method (PBP) (Chapter 5)
- ❑ Future worth method (FW) (Chapter 6)
- ❑ Annual worth method (AW) (Chapter 7)
- ❑ Internal rate of return method (IRR) (Chapter 8)
- ❑ External rate of return method (ERR) (Chapter 8)
- ❑ Modified internal rate of return (MIRR) (Chapter 8)
- ❑ Benefit/Cost ratio method (B/C) (Chapter 14)

Step 6: Perform Supplementary Analyses*

- GIGO
- Don't wade in rivers, on the average, two feet deep when wearing boots that are two feet tall!!
- Break-even analysis
- Sensitivity analysis
- Risk analysis
- Going the extra mile!
- Beware of “paralysis of analysis”

Break-even, Sensitivity, and Risk Analyses

Break-even analysis: determining the value of one or more parameters that will make the $PW=0$

Sensitivity analysis: determining the impact of a range of values for one or more parameters on the measure of merit

Risk analysis: determining the probability the $PW>0$, given probability distributions for one or more parameters

Step 7: Select the Preferred Alternative*

- Obtain the support of the users of the recommended system
- Pre-sell the recommendation
- Eliminate surprises
- Do not over-sell the technical aspects of the recommended system
- Technical aspects seldom convince management to make the required investment
- The decision-makers' perspectives are broad
- Know their priorities and tailor the economic justification package accordingly

Step 7: Select the Preferred Alternative*

- ❑ Relate the proposed investments to the well-being of the firm
- ❑ Show how the investment relates to the firm's strategic plan and stated corporate objectives
- ❑ Your proposal will be only one of many submitted and many will not be funded
- ❑ Failure to fund your proposal does not mean management is stupid
- ❑ Management's decision to fund your proposal does not mean they are brilliant
- ❑ Don't confuse unfavorable results with destiny

Step 7: Select the Preferred Alternative*

- ❑ Timing is everything!
- ❑ Profit maximization is not always the “name of the game,” but “selling” is!
- ❑ A firm’s ability to finance the proposal is as important as its economic merit
- ❑ Think big - you get what you pay for
- ❑ Don’t be penny-wise and dollar-foolish
- ❑ Remember the “Golden Rule,” those with gold make the rules!
- ❑ The less you bet the more you stand to lose in case you win!

Example 1.8

Weighted Factor Comparison of Alternatives

Three investment alternatives (A, B, and C) are being considered by the Ajax Mfg. Co. The PWs are \$25K, \$20K, and \$18K, respectively. There are differences in the quality (Q) of the tools being considered, the time (T) to fill a customer's order, and the reputations (R) of the tool suppliers.

Factors	Weights	Rankings		
		A	B	C
PW: present worth	30	10	8	7.2
Q: product quality	35	8	10	5
T: fill time	25	3	10	7
R: Supplier reputation	10	8	5	10

Weighted Factor Comparison Form

Company:

Prepared by:

Date:

Description of investment:

Factor	Wt.	A		B		C	
		Rt.	Sc.	Rt.	Sc.	Rt.	Sc.
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
Totals	100						

Weighted Factor Comparison Form

Company: Ajax Tool Co. Prepared by: JAW Date: April 1, 2009

Description of investment: order picking equipment for distribution center

Factor	Wt.	A		B		C	
		Rt.	Sc.	Rt.	Sc.	Rt.	Sc.
1. Present Worths	30	10	300	8	240	7.2	216
2. Product quality	35	8	280	10	350	5	175
3. Fill time, customer order	25	8	200	10	250	7	175
4. Supplier reputation	10	8	80	5	50	10	100
5.							
6.							
7.							
8.							
9.							
10.							
Totals	100		860		890		666



Weighted Factor Comparison Form

Company: Ajax Tool Co. Prepared by: JAW Date: April 1, 2009
 Description of investment: order picking equipment for distribution center

Factor	Wt.	A		B		C	
		Rt.	Sc.	Rt.	Sc.	Rt.	Sc.
1. Present Worths	40	10	400	8	320	7.2	288
2. Product quality	30	8	240	10	300	5	150
3. Fill time, customer order	20	8	160	10	200	7	140
4. Supplier reputation	10	8	80	5	50	10	100
5.							
6.							
7.							
8.							
9.							
10.							
Totals	100		880		870		678



Pit Stop #1—Checking Your Pulse

- **True or False:** If someone offers you the choice of receiving \$1000 today versus receiving \$1000 a year from today, you should take the money today if your time value of money is greater than zero.
- **True or False:** A strength of the weighted factor comparison technique is its scientific foundation and its elimination of subjectivity from decision making.
- **True or False:** If your time value of money is 10% annually, then you will be indifferent between receiving \$1000 today and receiving \$1100 one year from today.
- **True or False:** Based on the principles of engineering economic analysis, you should bet on the horse with the lowest odds to win, because risk and returns tend to be positively correlated.
- **True or False:** Every economic decision should be based on the time value of money.

Pit Stop #1—Checking Your Pulse

- **True or False:** If someone offers you the choice of receiving \$1000 today versus receiving \$1000 a year from today, you should take the money today if your time value of money is greater than zero. **TRUE**
- **True or False:** A strength of the weighted factor comparison technique is its scientific foundation and its elimination of subjectivity from decision making. **FALSE**
- **True or False:** If your time value of money is 10% annually, then you will be indifferent between receiving \$1000 today and receiving \$1100 one year from today. **TRUE**
- **True or False:** Based on the principles of engineering economic analysis, you should bet on the horse with the lowest odds to win, because risk and returns tend to be positively correlated. **FALSE**
- **True or False:** Every economic decision should be based on the time value of money. **FALSE**