GE403

Engineering Economy

First Term 1434-1435 H
The textbook for the course is

Background

• At various universities, this course is referred to as Engineering Economy, Engineering Economic Analysis, Economic Decision Making, Economic Analysis, and Economic Decision Analysis, among others.

• The subject will be approached from a cash flow perspective, i.e., the concern will be with monies spent and received (saved).
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!
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<th>Homework</th>
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  *Discount Payback Period*: Single Alternative, Multiple Alternatives, Sections: 5-6, 5-7  
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<td>and Average/Marginal Viewpoint. Section <strong>16-2</strong></td>
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# Grade Distribution

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<td>Final Exam</td>
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Chapter 1

Introduction to 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
Fundamental Concept

Money has a time value

- Would you rather receive $1000 today or $1000 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 $5,000 a year from today?
- Would you rather receive $1000 today or $10,000 a year from today?
- Would you rather receive $1000 today or $20,000 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 condominium
  ▪ 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
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.
Principles of Engineering Economic Analysis

- Money has a *time value*.
- Make investments that are *economically justified*.
- Choose the *mutually exclusive* investment alternative that maximizes economic worth.
- Two investment alternatives are *equivalent* if they have *the same economic worth*.
- *Marginal revenue* must exceed *marginal cost*.
Principles of Engineering Economic Analysis

- Continue to invest as long as each additional increment of investment yields a *return* that is *greater than* the investor’s *TVOM*.
- Consider *only differences* in cash flows among investment alternatives.
- *Compare investment alternatives* over a *common period of time*.
- *Risks* and *returns* tend to be positively correlated.
- *Past costs* are irrelevant in engineering economic analyses, unless they impact future costs.
Economic Justification
Seven Questions to Answer

- What investment alternatives are available?
- What is the length of time over which the decision is to be made?
- What TVOM will be used to move monies forward and/or backward in time?
- What are the best estimates of the cash flows for each alternative?
- Which investment alternative seems best, based on the economic criterion chosen?
- How sensitive is the decision to changes or errors in the estimates used in the analysis?
- Which investment is recommended?
Systematic Economic Analysis Technique (SEAT)

Seven-Step Procedure

- **Identify** the investment alternatives
- Define the *planning horizon*
- Specify the *discount rate*
- Estimate the *cash flows*
- *Compare* the alternatives
- Perform *supplementary analyses*
- **Select** the preferred alternative
Step 1: Identify the Feasible Alternatives

- Most *important step!*
- Beware the “*Do Nothing*” alternative
- Consider a *range of alternatives*
- 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

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Example 1.5 Forming Investment Alternatives from Investment Proposals

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<tr>
<td>8</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>Violates multiple constraints</td>
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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

* See Chapter 4
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

* See Chapter 4
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!

*see Chapter 16
Step 5: Compare the Investment Alternatives*

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

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

*see Chapter 13
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

*see Chapter 15
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
Step 7: Select the Preferred Alternative

- Don’t confuse unfavorable results with destiny
- 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
- 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!
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 of 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**