Marmara University, Engineering Faculty

Engineering Economy
Spring 2021

Prepared by

Serhat Temizkan

ECON PROFESSOR

LEARNING OUTCOMES

1. Engineering and Decision Making
2. Application of Economics in Eng.
3. Interest and Financial Costs
4. Public Tenders and Purchasing
5. Investment and R&D Costs
6. Production & Start up
7. Marketing and Sales
8. Taxation in Turkey

Why Engineering Economy is Important?

- Engineers design and create
- Designing involves economic decisions
- Engineers must be able to incorporate economic analysis into their creative efforts
- Often engineers must select and implement from multiple alternatives
- Understanding and applying time value of money, economic equivalence, and cost estimation are vital for engineers
- ENGINEERS MUST OBTAIN THE MAXIMUM OUTPUT WITH MINIMUM INPUT

Engineering Economy

- Engineering Economy involves
  - Formulating
  - Estimating
  - Evaluating

    expected economic outcomes of alternatives designed to accomplish a defined purpose
- Easy-to-use math techniques simplify the evaluation

General Steps for Decision Making Processes

1. Understand the problem – define objectives
2. Collect relevant information
3. Define the set of feasible alternatives
4. Identify the criteria for decision making
5. Evaluate the alternatives and apply sensitivity analysis
6. Select the "best" alternative
7. Implement the alternative and monitor results

Interest and Interest Rate

- **Interest** – the manifestation of the time value of money
  - Fee that one pays to use someone else's money
  - Difference between an ending amount of money and a beginning amount of money

  - Interest = amount owed now – principal(anapara)

- **Interest rate** – Interest paid over a time period expressed as a percentage of principal

  - $$\text{Interest rate}(\%) = \frac{\text{interest accrued per time unit}}{\text{principal}} \times 100\%$$

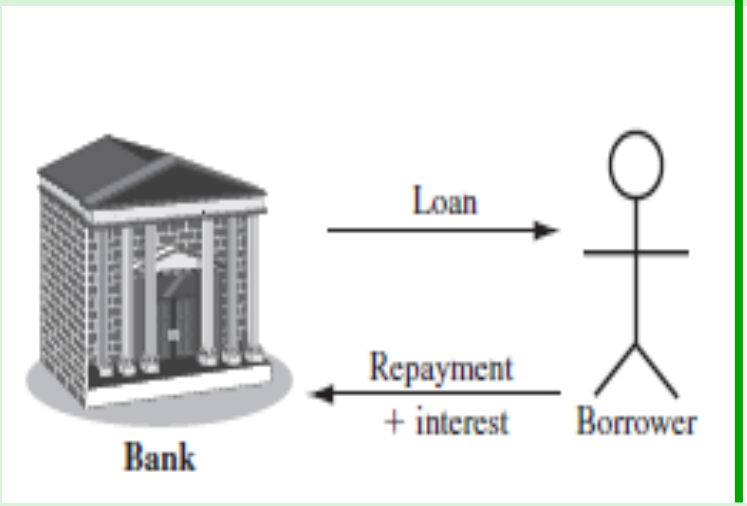
Rate of Return

- **Interest earned over a period of time is expressed as a percentage of the original amount (principal)**

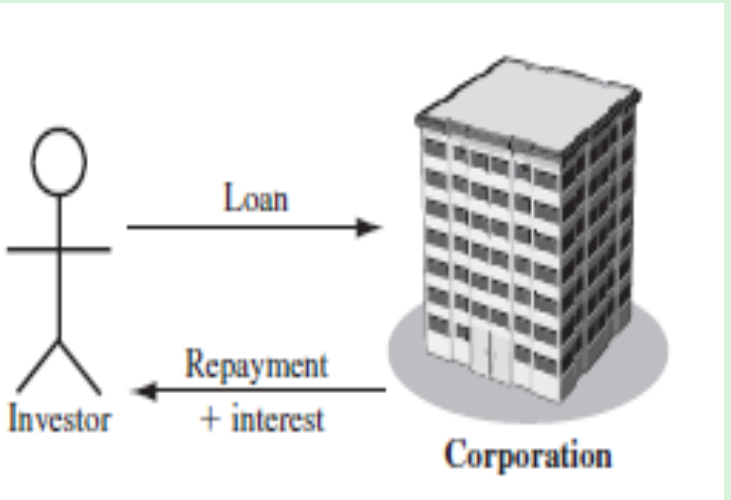
$$\text{Rate of return (\%)} = \frac{\text{interest accrued per time unit}}{\text{original amount}} \times 100\%$$

- Borrower's perspective – interest rate paid
- Lender's or investor's perspective – rate of return earned

Interest paid



Interest earned



Interest rate

Rate of return

Commonly used Symbols

t = time, usually in periods such as years or months

P = value or amount of money at a time *t* designated as present or time 0

F = value or amount of money at some future time, such as at *t* = *n* periods in the future

A = series of consecutive, equal, end-of-period amounts of money

n = number of interest periods; years, months

i = interest rate or rate of return per time period; percent per year or month

Cash Flows: Terms

- **Cash Inflows** – Revenues (R), receipts, incomes, savings generated by projects and activities that flow in. Plus sign used
- **Cash Outflows** – Disbursements (D), costs, expenses, taxes caused by projects and activities that flow out. Minus sign used
- Net Cash Flow (NCF) for each time period:

  NCF = cash inflows – cash outflows = R – D
- **End-of-period assumption:**

  Funds flow at the end of a given interest period

Cash Flows: Estimating

- ✓ **Point estimate – A single-value estimate of a cash flow element of an alternative**

  Cash inflow: Income = $150,000 per month

- ✓ **Range estimate – Min and max values that estimate the cash flow**

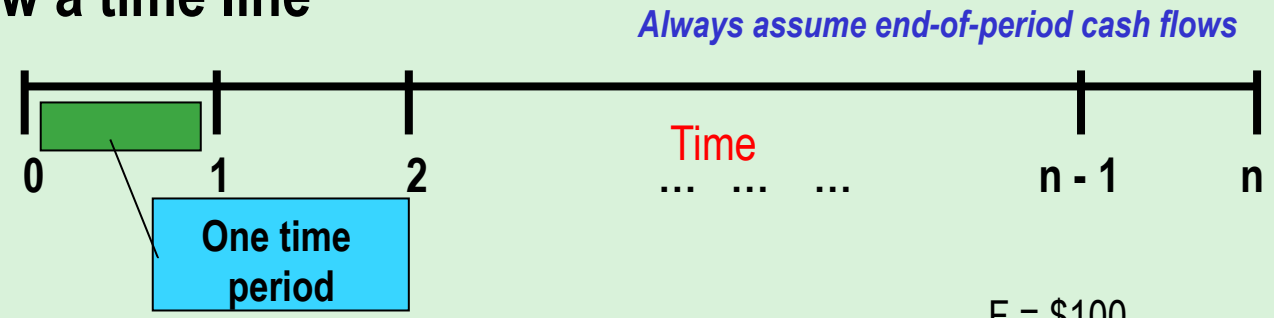
  Cash outflow: Cost is between $2.5 M and $3.2 M

Point estimates are commonly used; however, range estimates with probabilities attached provide a better understanding of variability of economic parameters used to make decisions

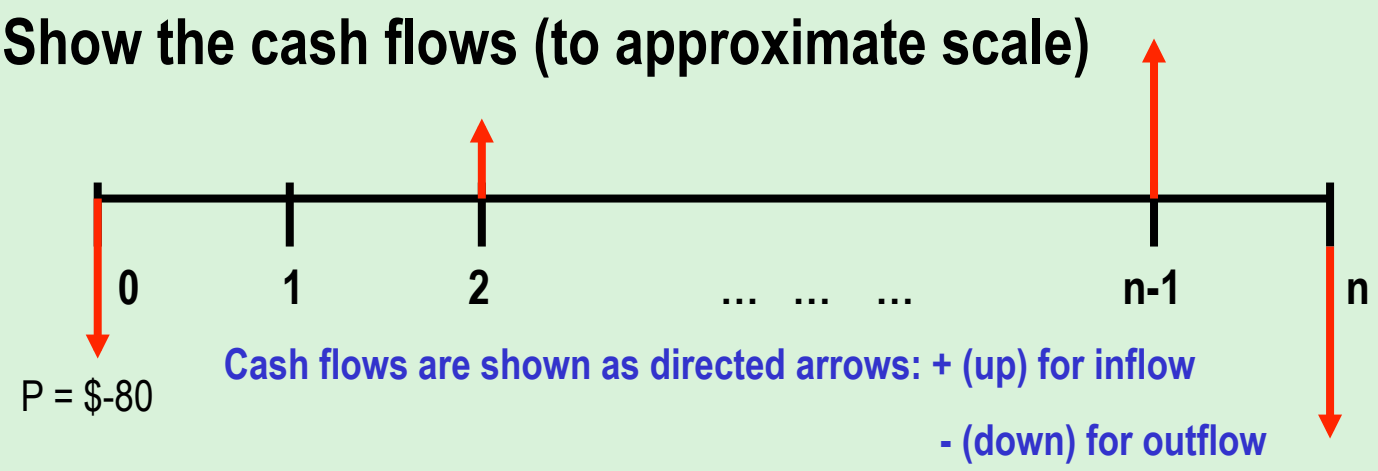
Cash Flow Diagrams

What a typical cash flow diagram might look like

Draw a time line



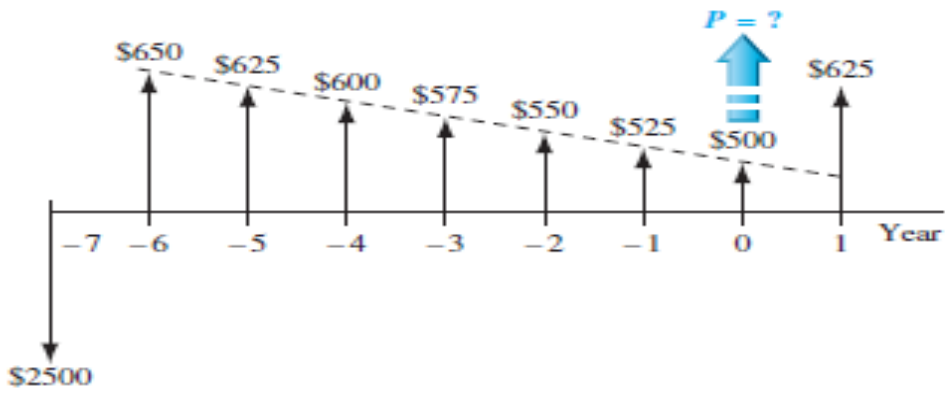
Show the cash flows (to approximate scale)



Cash Flow Diagram Example

Plot observed cash flows over last 8 years and estimated sale next year for $150. Show present worth (P) arrow at present time, t = 0

End of Year	Income	Cost	Net Cash Flow
−7	$ 0	$2500	$−2500
−6	750	100	650
−5	750	125	625
−4	750	150	600
−3	750	175	575
−2	750	200	550
−1	750	225	525
0	750	250	500
1	750 + 150	275	625



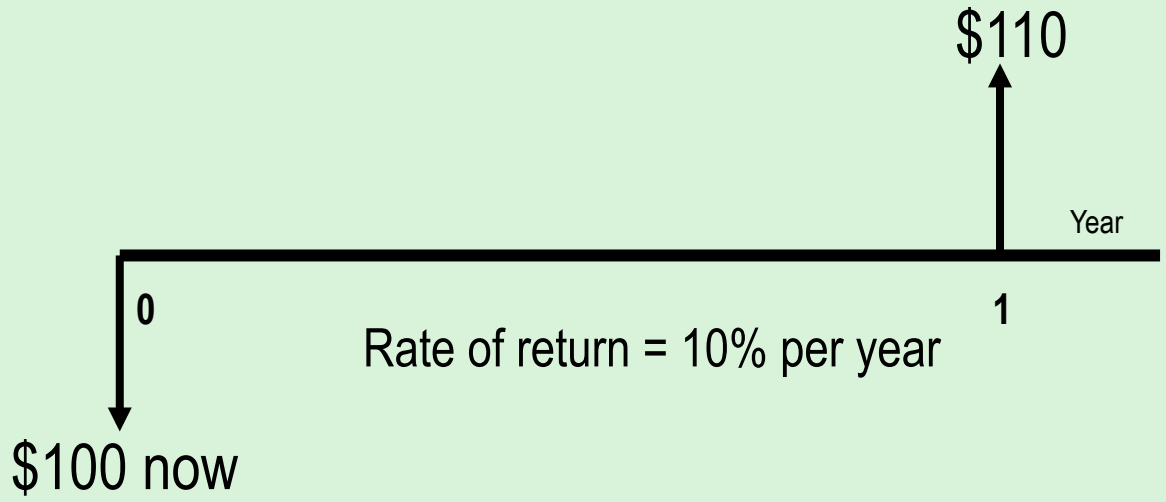
Economic Equivalence

Definition: Combination of interest rate (rate of return) and time value of money to determine different amounts of money at different points in time that are economically equivalent

How it works: Use rate *i* and time *t* in upcoming relations to move money (values of P, F and A) between time points $t = 0, 1, \ldots, n$ to make them equivalent (not equal) at the rate *i*

Example of Equivalence

Different sums of money at different times may be equal in economic value at a given rate



$100 now is economically equivalent to $110 one year from now, if the $100 is invested at a rate of 10% per year.

Simple and Compound Interest

- **Simple Interest**

  Interest is calculated using principal only

  Interest = (principal)(number of periods)(interest rate)

  $I = Pni$

Example: $100,000 lent for 3 years at simple i = 10% per year. What is repayment after 3 years?

Interest = 100,000(3)(0.10) = $30,000

Total due = 100,000 + 30,000 = $130,000

Simple and Compound Interest

- **Compound Interest**

  Interest is based on principal plus all accrued interest

  That is, interest compounds over time

Interest = (principal + all accrued interest) (interest rate)

Interest for time period *t* is

$$I_t = \left(P + \sum_{j=1}^{j=t-1} I_j\right)(i)$$

Compound Interest Example

Example: $100,000 lent for 3 years at *i* = 10% per year compounded. What is repayment after 3 years?

Interest, year 1: $I_1 = 100{,}000(0.10) = \$10{,}000$

Total due, year 1: $T_1 = 100{,}000 + 10{,}000 = \$110{,}000$

Interest, year 2: $I_2 = 110{,}000(0.10) = \$11{,}000$

Total due, year 2: $T_2 = 110{,}000 + 11{,}000 = \$121{,}000$

Interest, year 3: $I_3 = 121{,}000(0.10) = \$12{,}100$

Total due, year 3: $T_3 = 121{,}000 + 12{,}100 = \mathbf{\$133{,}100}$

Compounded: $133,100	Simple: $130,000