CB 311
Introduction to Construction Management

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Engineering Economics

What is engineering economics?

- It is the scientific approach in analyzing designs and alternatives to evaluate their worth and value.

Examples of Engineering Economics Usage

- Purchase of new excavator vs repairing old one.
- Long term vs. short term investments
- Comparison between two infrastructure projects

Engineering Economics

Economic Concepts & How time and Interest affect money

- Factors
- Nominal & Effective Int. Rates

Tools for Evaluating Alternatives

- NPV
- EAW
- ROR
- B/C

Making Decisions on Real World Projects

- Replacement Decision
- Breakeven Analysis

Rounding up the Study

- Depreciation
- Sensitivity Analysis
- Economic Feasibility

Study Approach (Blank and Tarquin, 2005)

Problem identified; objective defined

Alternative 1

New equipment

Description and information

Cash flows over some time periods

Analysis (engineering economy mode)

Evaluate Alternative 1

7/10

Alternative 2

Upgrade old equipment

Description and information

Cash flows over some time periods

Analysis (engineering economy model)

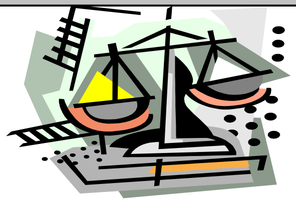
Evaluate Alternative 2

8/10

- Income and cost estimates.
- Financing strategies.
- Tax laws.

- Time value of money.
- Interest rate.
- Measure of worth.

- Calculated value of measure of worth.



Non- economic attributes to be considered

Select alternative 1

Implement alternative 1

Time Value of Money

- A dollar’s value today is higher than in the future.



- Borrowing Gold, vs Cattle, vs Money

Time



Interest rate

- **Interest**: it is a measure of increase between the original sum borrowed or invested and the final amount owned or accrued

Interest = Total amount accumulated – Original Investment

Interest = Present amount owed – Original Loan

$$Interest\ Rate = \frac{interest\ accured\ per\ unit\ time}{Original\ amount}\ X\ 100\%$$

Example

A contractor borrows $10,000 from the bank on May 1st and must repay a total of $10,700 exactly one year later. Determine the interest amount and the interest rate paid.

- Solution

Interest per year = $ 10,700 – 10,000 = $ 700

Present interest rate = $\frac{\$\,700}{\$\,10{,}000} X100\% = 7\%\ per\ year$

Example

- Lets say you plan to borrow \$ 20,000 from a bank for 1 year at 9 % interest for new a new car. Compute the interest and the total amount due after 1 year.

Solution

Interest = \$ 20,000(0.09) = \$ 1800

The total amount due is the sum of principle and interest.

Total due = \$ 20,000 + 1800 = \$ 21,800

Example

- Calculate the amount deposited 1 year ago to have $ 1000 now at an interest rate of 5 % per year.
- Calculate the amount of interest earned during this time period.

Solution

a) The total amount accrued is the sum of the original deposit and the earned interest. If x is the original deposit,

Total accrued = original + original (interest rate)

$ 1000 = X + X (0.05) = X (1+0.05) = 1.05 X

the original deposit is X = 1000/1.05 = $ 952.38

b) Interest earned.

Interest = $ 1000 – 952.38 = $ 47.62

Equivalence

- Going back to time value of money and interest rates, we developed the concept of Economic Equivalence.

- Economic equivalence means that different sums of money at different times will be of equal economic value

Example

- Assume you are storing steel for projects throughout the next year. If the storage of steel cost around 5% per year of the total cost, determine which of the following statements are true.

a. The amount of $ 98 now is equivalent to a cost of $ 105.60 one year from now.

b. A ton of steel costs o$ 200 one year ago is equivalent to $ 205 now.

c. A $38 cost now is equivalent to $ 39.90 one year from now.

d. A $3000 cost now is equivalent to $2887.14 one year ago.

e. The carrying charge accumulated in 1 year on an investment of $ 2000 worth of steel is $ 100.

Solution

a) Total amount accrued = 98(1.05) = $ 102.90 ≠ 105.60: therefore, it is false.
   Another way to solve this is as follows:

   required original cost is 105.60/1.05 = $ 100.57 ≠ $ 98.

b) Required old cost is 205.00/1.05 = $ 195.24 ≠ $ 200; therefore, it is false.

c) The cost 1 year from now is $ 38(1.05) = $ 39.90; true.

d) Cost now is 2887.14(1.05) = $ 3031.5; false.

e) The charge is 5 % per year interest, or 2000(0.05) = $ 100; true.

Key Parameters in Engineering Economics

- Interest rate and amount
- Time, or number of periods
- Present value
- Future value
- Period values

Terminology

- I =amount of interest paid
- i = interest rate per period of time
- n = number of periods
- P = initial value, principal
- F = future value after n periods
- A = series of payment of periodic values

Simple interest rate

- What we learned so far is a simple interest rate

$$F = P + I$$

$$I = P * n * i$$

$$F = P * (1 + n * i)$$

- This approach does not accumulate interests overtime.

Example

An engineering company has loaned money to a staff engineer. The loan is $1000 for 3 years at 5% per year simple interest. How much money will the engineer repay at the end of 3 years?

Solution

The interest for each year of the 3 years is = 1000 (0.05) = $ 50

- Total interest for 3 years = P n i = 1000 (3) (0.05) = $ 150
- The amount due after 3 years = P + P n i = 1000 + 150 = $ 1150

Compound Interest

- Unlike simple interest, compound interest accumulates the interest amount at the end of each period on the principal value. Thus, the new interest amount will larger given a higher principal value.

Example

An engineering company has loaned money to a staff engineer. The loan is $1000 for 3 years at 5% per year simple interest. How much money will the engineer repay at the end of 3 years? Solution

Year 1 interest = 1000 (0.05) = $ 50

Total amount due after 1 year = 1000 + 50 = $ 1050

Year 2 interest = 1050 (0.05) = $ 52.50

Total amount due after 2 year = 1050 + 52.5 = $ 1102.50

Year 3 interest = 1102.50 (0.05) = $ 55.13

Total amount due after 3 year = 1102.50 + 55.13 = $ 1157.63

Can you come up with a general formula for this

Compound Interest Formula

$$P = F\left[\frac{1}{(1+i)^n}\right]$$

$$F = P\,(1+i)^n$$

$$P = A\left[\frac{(1+i)^n - 1}{i(1+i)^n}\right]$$

$$A = P\left[\frac{i(1+i)^n}{(1+i)^n - 1}\right]$$

$$A = F\left[\frac{i}{(1+i)^n - 1}\right]$$

$$F = A\left[\frac{(1+i)^n - 1}{i}\right]$$

Example

- Suppose that $ 1,000 is borrowed at a rate of 16 % interest per annum. If this loan was for a 4 – year period, calculate and show:

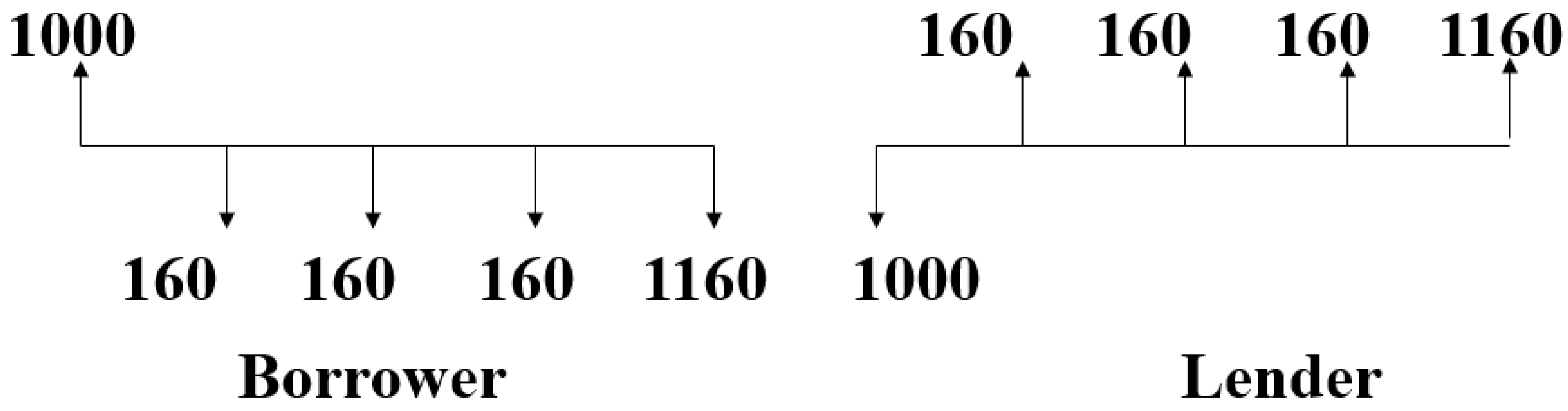
a. The payment per year.

b. The amount that has to be paid at the end of four year, if payments were not paid annually.

Cash Flow Diagram

- A diagram the illustrates the inflow and outflows of money (cash in and cash out).

- An arrow donates if the cash is withdrawn or added



Example

A father works to deposit an unknown lump – sum amount into an investment opportunity 2 years from now that is large enough to withdraw $ 4000 per year for state university tuition for 5 years starting 3 years from now. If the rate of return is estimated to be 15.5% per year, construct the cash flow diagram.