Engineering Economics Formula Sheet

Cost Indexes:

$$\frac{\text{Cost at time A}}{\text{Cost at time B}} = \frac{\text{Index value at time A}}{\text{Index value at time B}}$$

Power sizing:

$$\frac{\text{Cost of asset A}}{\text{Cost of asset B}} = \left[\frac{\text{Size (capacity) of asset A}}{\text{Size (capacity) of asset B}}\right]^x$$

x = power-sizing exponent

Learning Curve:

$$T_N = T_{initial} \times N^b$$

$$b = \frac{\log(\text{learning curve rate})}{\log 2}$$

T_N = time to make Nth unit

$T_{initial}$ = time to make first unit

N = number of finished units

b = learning curve exponent

Simple Interest:

Interest earned on amount P: $I = Pin$

Maturity value: $F = P(1 + in)$

i = interest rate per time period

n = number of time periods

Compound Interest (Single Payment):

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

F = future value

P = present value

i = periodic interest rate

n = number of periods

Effective Interest Rates:

$$i = \frac{r}{m}$$

$$(1 + i_{eff}) = \left(1 + \frac{r}{m}\right)^m$$

i = periodic interest rate

r = nominal interest rate per year

m = number of compounding periods per year

i_{eff} = effective interest rate (compounded annually)

Annuity Due:

[Appropriate formula for question](1+i)

Perpetual Annuities:

$$P = \frac{A}{i}$$

Geometric Growth: $P = \dfrac{A}{i - g}; i > g$

General Annuity:

$$(1 + i_{eq})^p = (1 + i_c)^c$$

$$i_{eq} = (1 + i)^{c/p} - 1$$

i_{eq} = interest rate for payment period

p = number of payment periods per year

i_c = interest rate for compounding period

c = number of compounding periods per year

Ordinary Simple Annuity (Uniform Series):

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

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

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

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

A = periodic payment (end of period)

P, F, i, n as above for compound interest

Arithmetic Gradient Annuity:

$$A_{eq} = G\left[\frac{1}{i} - \frac{n}{(1+i)^n - 1}\right]$$

$$P = G\left[\frac{(1+i)^n - in - 1}{i^2(1+i)^n}\right]$$

A_{eq} = equivalent periodic payment

G = gradient amount (periodic increment)

P, i, n as above for compound interest

Geometric Gradient Annuity:

$$P = A_1\left[\frac{1 - (1+g)^n(1+i)^{-n}}{i - g}\right]; i \neq g$$

$$P = \frac{nA_1}{(1+i)}; i = g$$

$$F = A_1\left[\frac{(1+i)^n - (1+g)^n}{i - g}\right]; i \neq g$$

$$F = nA_1(1+i)^{n-1}; i = g$$

A_1 = payment in first period (end)

g = periodic rate of growth

P, F, i, n as above for compound interest

Engineering Economics Formula Sheet is an essential tool for engineers, project managers, and decision-makers in evaluating the financial viability of engineering projects. Engineering economics combines principles of engineering with economic theory to assess the economic feasibility of projects, investments, and designs. This article provides a comprehensive overview of key concepts, formulas, and applications of engineering economics, serving as a valuable reference for students and professionals alike.

Understanding Engineering Economics

Engineering economics focuses on the evaluation of the economic aspects of engineering projects. It helps in making informed decisions about investments by analyzing costs, benefits, and the time value of money. The goal is to ensure that resources are allocated efficiently while maximizing returns.

Core Concepts

1. Time Value of Money (TVM): The principle that a dollar today is worth more than a dollar in the future due to its potential earning capacity.
2. Cash Flow Analysis: The process of tracking the inflows and outflows of cash over time to assess project viability.
3. Cost-Benefit Analysis (CBA): A systematic approach to comparing the strengths and weaknesses of alternatives in business decisions.
4. Interest Rates: The cost of borrowing money, which impacts the overall investment returns.

Key Formulas in Engineering Economics

In engineering economics, several formulas are frequently utilized to analyze financial data and make informed decisions. Below are the most important ones.

1. Future Value (FV)

The future value of a single sum of money can be calculated using the formula:

$$
FV = PV \times (1 + r)^n
$$

Where:
- FV = Future Value
- PV = Present Value
- r = Interest Rate (as a decimal)
- n = Number of periods

2. Present Value (PV)

The present value formula helps determine the current worth of a future sum of money:

$$
PV = \frac{FV}{(1 + r)^n}
$$

Where:
- PV = Present Value
- FV = Future Value
- r = Interest Rate (as a decimal)
- n = Number of periods

3. Net Present Value (NPV)

NPV is a critical metric for evaluating the profitability of an investment:

$$
NPV = \sum \left(\frac{CF_t}{(1 + r)^t} \right) - C_0
$$

Where:
- NPV = Net Present Value
- CF_t = Cash flow at time t
- r = Discount rate
- t = Time period
- C_0 = Initial investment

4. Internal Rate of Return (IRR)

IRR is the discount rate that makes the NPV of a project zero. There is no explicit formula for IRR; it is typically found using financial calculators or software. However, it can be approximated through iterative methods or interpolation.

5. Payback Period (PP)

The payback period measures how long it takes to recover the initial investment:

$$
PP = \frac{C_0}{CF}
$$

Where:
- PP = Payback Period

- C_0 = Initial investment
- CF = Annual cash flow

6. Benefit-Cost Ratio (BCR)

BCR evaluates the ratio of benefits to costs:

$$
BCR = \frac{\text{Total Present Value of Benefits}}{\text{Total Present Value of Costs}}
$$

A BCR greater than 1 indicates a potentially profitable investment.

Applications of Engineering Economics

Engineering economics is applied in various fields, including civil engineering, mechanical engineering, and industrial engineering. Here are some common applications:

1. Project Feasibility Studies

Before initiating a project, engineers conduct feasibility studies to assess whether the investment is worthwhile. This includes analyzing cash flows, calculating NPV, and determining the IRR.

2. Equipment Selection

When selecting machinery or equipment, engineering economics helps compare the costs and benefits of different options. Factors such as maintenance costs, operational efficiency, and lifespan are considered.

3. Cost Estimation

Accurate cost estimation is crucial for budgeting and financial planning in engineering projects. Engineers use historical data, expert judgment, and economic models to estimate costs.

4. Risk Analysis

Engineering projects often involve uncertainties. Risk analysis techniques, such as sensitivity analysis and scenario planning, help assess the potential impact of risks on project outcomes.

Considerations in Engineering Economics

When applying engineering economics principles, several factors must be taken into account:

1. Economic Life of an Asset

The economic life of an asset refers to the period during which it remains economically viable. Understanding this helps in making decisions about when to replace or upgrade equipment.

2. Escalation of Costs

Inflation can significantly affect project costs. Engineers must factor in potential cost escalations when estimating expenses for long-term projects.

3. Tax Implications

Tax considerations can influence investment decisions. Understanding tax benefits, depreciation methods, and tax credits can optimize project cash flows.

4. Financing Options

Various financing options, such as loans, equity, and grants, can impact the overall cost of a project. Engineers should evaluate the implications of different financing methods on profitability.

Conclusion

The Engineering Economics Formula Sheet serves as a vital resource for professionals in the field. By understanding and applying the key concepts and formulas outlined in this article, engineers can make informed decisions that enhance project viability and profitability. Mastery of engineering economics not only empowers engineers to optimize resource allocation but also ensures that engineering projects contribute positively to the organization and society. As the field of engineering continues to evolve, the importance of integrating economic analysis into engineering practices will only grow, making a solid understanding of these principles essential for future success.

Frequently Asked Questions

What is engineering economics?

Engineering economics is a subset of economics that deals with the evaluation of the economic performance of engineering projects, considering factors like costs, benefits, and time. It helps engineers make informed decisions about project viability and financial investments.

What are the key formulas included in an engineering economics formula sheet?

Key formulas typically include Present Worth (PW), Future Worth (FW), Annual Worth (AW), Rate of Return (ROR), and Benefit-Cost Ratio (BCR), among others. These formulas help in analyzing cash flows over time.

How is the Present Worth (PW) calculated?

The Present Worth (PW) is calculated using the formula: $PW = F / (1 + i)^n$, where F is the future cash flow, i is the interest rate, and n is the number of periods until the cash flow occurs.

What is the significance of the Annual Worth (AW) in engineering economics?

The Annual Worth (AW) represents the constant annual cash flow equivalent to a project's net cash flow over its lifespan. It is significant for comparing projects with different lifespans and cash flow patterns.

What does the Benefit-Cost Ratio (BCR) indicate?

The Benefit-Cost Ratio (BCR) indicates the relationship between the benefits and costs of a project. A BCR greater than 1 implies that benefits exceed costs, suggesting that the project is economically viable.

How do you determine the Rate of Return (ROR) for an engineering project?

The Rate of Return (ROR) is determined by solving the equation where the present worth of cash inflows equals the present worth of cash outflows. This often requires iterative methods or financial calculators to find the interest rate that satisfies this condition.

Why is sensitivity analysis important in engineering economics?

Sensitivity analysis is important because it assesses how sensitive the project's outcomes are to changes in key assumptions or input variables, such as interest rates or cash flows. This helps identify risks and uncertainties in project evaluations.

What role does inflation play in engineering economic analysis?

Inflation affects the purchasing power of money over time, influencing cash flow estimates and project costs. Engineering economic analyses must account for inflation to ensure accurate evaluations of project viability and financial returns.

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