ENGINEERING ECONOMIC ANALYSIS

Annual Cash Flow Analysis

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Learning Objective

01

Introduction to Annual Cash Flow Analysis

02

Capital Recovery Cost

03

Comparing Alternatives

04

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Practice Problems

Part 01

Introduction toAnnual CashFlow Analysis

01. What is Annual Cash Flow Analysis?

Definition & Core Metrics

Annual Cash Flow Analysis converts all cash inflows and outflows of a project into equivalent uniform annual amounts. This method is a cornerstone in engineering economics, especially useful when comparing investment alternatives with significantly different life spans.

EUAC
Equivalent Uniform Annual Cost
The annual cost of owning/operating an asset.

EUAB
Equivalent Uniform Annual Benefit
The annual benefit derived from a project.

EAW (Equivalent Annual Worth) = EUAB - EUAC
The net annual value of a project; the primary decision criterion

Key Scenarios for Use

Unequal Project Lifespan
The best method to compare alternatives with different useful lives, avoiding the need for the least common multiple (LCM) of lives.

Loan & Amortization
Calculating fixed annual payments for mortgages, car loans, or any capital borrowing with compound interes

Budget & Cash Mgmt
Businesses often think in terms of annual budgets. This method aligns project economics with standard accounting cycles.

Intuitive Understanding
For non-experts, an annual cost ($/year) is far more understandable and relatable than a large present value ($) lump sum.

Part 02

01. Capital Recovery Cost

Three Equivalent Methods

All three methods give the same result for EUAC with salvage value:

Method 1:

EUAC = P(A/P, i, n) - S(A/F, i, n)

Method 2:

EUAC = (P-S)(A/F, i, n) + Pi

Method 3:

EUAC = (P-S)(A/P, i, n) + Si

Example Calculation

Problem:

Calculate EUAC for equipment with P = $1,000, S = $200, n = 10, i = 7%

Method 1:

EUAC = 1000(A/P, 7%, 10) - 200(A/F, 7%, 10)

EUAC = 1000(0.1424) - 200(0.0724)

EUAC = 142.40 - 14.48

EUAC = $127.92

Verify with Method 2 or 3 - same result!

Key: All methods account for both depreciation and interest on investment

Part 03

Comparing Alternatives

01.

Equal Lives

When alternatives have the same life, compare EUAC directly.

Example:

Two machines, both with 5-year lives

Machine A: EUAC = $1,200

Machine B: EUAC = $1,100

Select Machine B (lower EUAC)

Different Lives

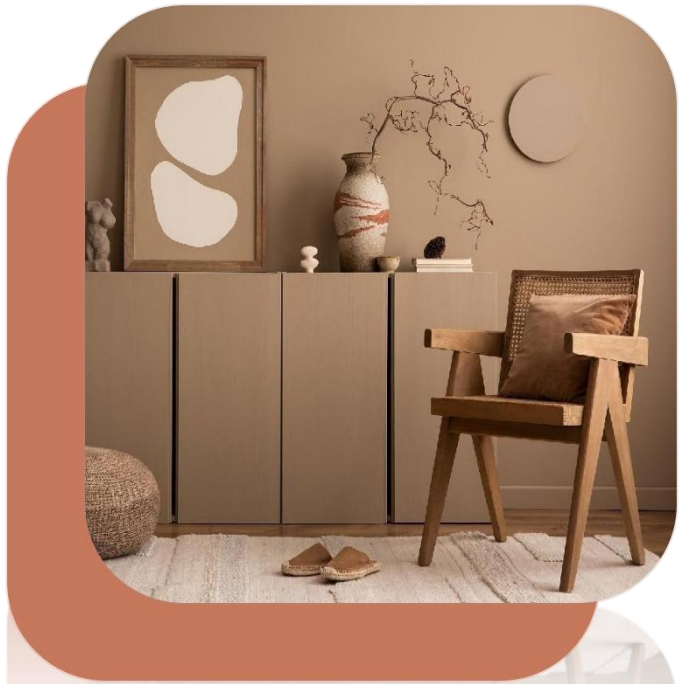
Annual cash flow analysis can directly compare alternatives with different lives.

Key Assumption:

Identical replacement - each alternative is replaced with an identical unit at the end of its life

02.

Example: Different Lives



Pump Selection, i = 7%:

Pump A:

Cost $7,000, S = $1,500, n = 12

EUAC = (7000-1500)(A/P,7%,12) + 1500(0.07)

EUAC = 5500(0.1259) + 105 = $797

Pump B:

Cost $5,000, S = $1,000, n = 9

EUAC = (5000-1000)(A/P,7%,9) + 1000(0.07)

EUAC = 4000(0.1535) + 70 = $684

Decision: Select Pump B (Lower EUAC: $684 vs $797)

Part 04

Loan Amortization

What is Amortization?

Loan amortization： is the process of paying off a loan through regular payments that cover both principal and interest.

Payment Components:

Interest: Cost of borrowing

Principal: Reduction of loan balance

Payment = Interest + Principal

Loan Balance Formula：

Finding Balance After k Payments:

Formula: $B_k = P(1+i)^k - A[(1+i)^k - 1]/i$

Key Insight: Early payments are mostly interest; later payments are mostly principal.

Total Interest: Total Payments - Principal = Total Interest Paid

Practice Problems

EUAC Calculation

Machine Comparison

Car Loan Analysis

nvestment Decision

Problem 1： EUAC Calculation

Calculate the EUAC for equipment with:

Initial cost = $8,000

Salvage value = $1,500

Life = 6 years

Interest rate = 10%

EUAC = (P-S)(A/P,i,n) + Si

$$= \frac{0.1（1+0.1）^{6}}{（1+0.1）^{6}-1} \times （8000-5000）+1500 \times 0.1$$

$$= 1492.4 + 150 = \$1,642.45$$

Problem 2： Machine Comparison

wo machines are being considered:

Machine A: Cost $5,000, annual operating cost $1,200, life 4 years, salvage $800

Machine B: Cost $7,000, annual operating cost $900, life 6 years, salvage $1,200

At 12% interest, which machine should be selected using EUAC analysis?

Compare EUAC of both machines

$$(\text{A/P},12\%,4) = \frac{0.12(1+0.12)^4}{(1+0.12)^4-1} = 0.3292$$

$$EUAC_A = (5000 - 800) \times 0.3292 + 800 \times 0.12 + 1200 = 2618.64$$

$$EUAC_B = (7000 - 1200) \times \frac{0.12(1+0.12)^6}{(1+0.12)^6 - 1} + 1200 \times 0.12 + 900 = 2454.56$$

Choose B

Problem 3： Car Loan Analysis

A car loan of $25,000 is taken at 9% annual interest for 5 years with monthly payments. Calculate:

a) The monthly payment

b) The total interest paid over the life of the loan

c) The balance remaining after 2 years

a) A = P(A/P, i, n)

$$= 25000 \times \frac{0.0075(1+0.0075)^{60}}{(1+0.0075)^{60}-1} = 519$$

b) total interest = 519 ×60 -25000 = 6140

c) $B_{24} = 25000(1.0075)^{24} - 519 \times \frac{(1.0075)^{24}-1}{0.0075} = 16420$

Problem 4：nvestment Decision

A company is considering purchasing a machine for $50,000 that will save $12,000 annually in operating costs. The machine has a 6-year life and $5,000 salvage value

At 15% interest, should the machine be purchased? (Use EUAW analysis)

EUAW = Annual Savings - EUAC

$$EUAC = (50000 - 5000) \times \frac{0.15(1+0.15)^6}{(1+0.15)^6-1} + 0.2642 + 5000 \times 0.15 = 12639$$

EUAW = 12000 - 12639 = -639

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Part 6

Key Takeaways & Next Session Preview

Key Takeaways

1. Annual Cash Flow

• EUAC and EUAB convert all project cash flows into equivalent uniform annual amounts.

• They enable fair comparisons between alternatives with different service lives.

2. Capital Recovery

• Three equivalent calculation methods are available for EUAC with salvage value.

• All three methods yield the same final result.

3. Loan Amortization

• Each loan payment includes both interest and principal repayment.

• Interest accounts for most of early-period payments.

Next Session Preview

1. Rate of Return Analysis
• Calculate Internal Rate of Return (IRR) for single projects.
• Conduct incremental rate-of-return analysis for competing options.

2. Investment Decisions
• Compare different investment alternatives using rate-of-return metrics.
• Support rational capital-investment decision-making.