1. Engineering Economics and Economic Equivalence

By: Syeda Iqra Gillani
Department of Software Engineering
MUST

Overview of Today's Lecture

Introduction to Engineering Economics

Time Value of Money

Economic Equivalence

Cash Flow Diagrams

Real-Life Engineering Examples

Practice Problems and Activities

1. Warm-Up Discussion

“If you design a bridge that costs more than its benefit — is it still a success?”

Engineering ≠ Just Design — It’s Decision-Making

1.1 What Is Engineering Economics?????

THINK ABOUT IT AND NOTE DOWN ON A PAPER, SWAP YOUR ANSWERS WITH YOUR PEERS AND READ ALOUD

Definition:

Application of economic principles to engineering problems for cost-effective decision-making.

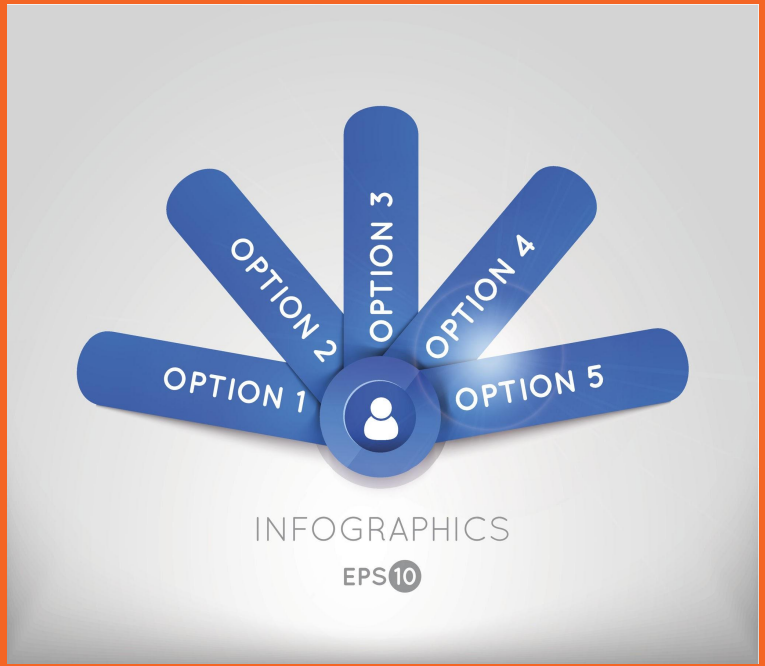
EXAMPLES

Choosing between two machines.
Estimating project feasibility.
Replacement of equipment.

Importance in Real Life

Every engineer faces financial choices:

- Buy or lease?
- Maintain or replace?
- Invest now or later?



Example

Example: Electric vs. petrol company vehicles

Engineering Decisions Have Two Sides

Technical Side

Performance, design

Functionality

Innovation

Economic Side

Cost, value, return

Profitability

Investment

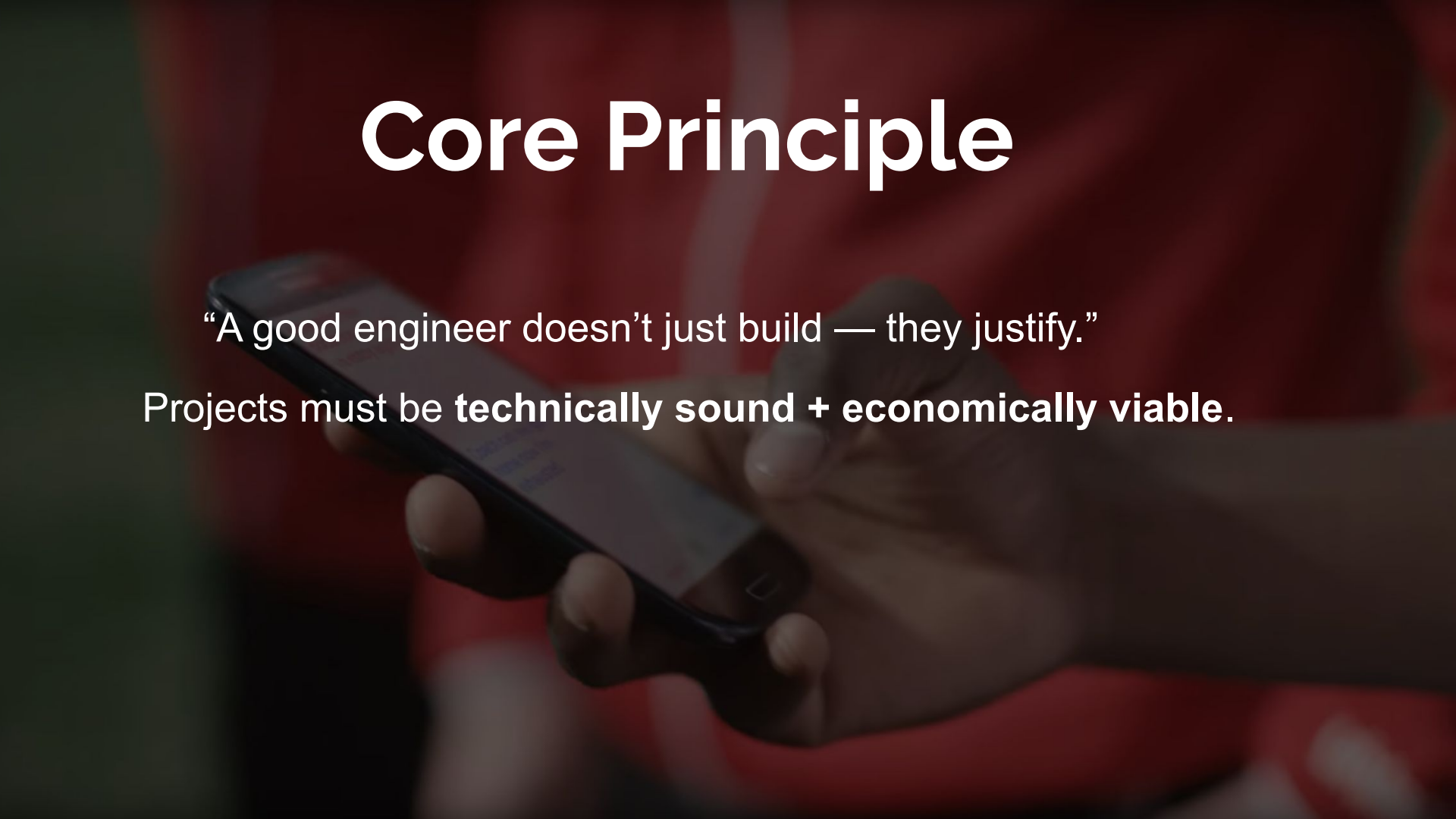
Example: Choosing a Product

Option A: Rs. 100,000, lasts 5 years

Option B: Rs. 160,000, lasts 8 years

Which is better?

👉 Need to compare costs over time → economic equivalence



Core Principle

“A good engineer doesn’t just build — they justify.”

Projects must be **technically sound + economically viable**.

Key Concepts in Engineering Economics

Time Value of Money

Cost Estimation

Cash Flow Analysis

Alternatives Comparison

Decision Criteria

Role of Money in Engineering

Source of funding

Cost driver

Decision base

Performance indicator

Class Activity 1

Would you prefer Rs. 10,000 today or Rs. 12,000 next year?

Take a quick poll.

Then ask: *Why?*

Economics in Daily Life

Examples:

- **Buying mobile on cash vs. installment**
- **Car financing vs. cash payment**
- **Solar panel investment**

Learning Paths

Step 1: Understand value of money
Step 2: Learn interest and growth
Step 3: Apply equivalence
Step 4: Make engineering decisions

Terms to Know

1. Principal
2. Interest
3. Cash Flow
4. Rate of Return
5. Opportunity Cost

Quick Recap Quiz

Q1. What is engineering economics?

Q2. Why is cost analysis important?

Q3. Give one real-life example.

1.2 Time Value of Money

Goal: Build the foundation for equivalence.

Time Value of Money (TVM)

"Money today is worth more than the same money tomorrow."

Interest + Opportunity Cost

Time Value of Money (TVM)

Lecture script (detailed):
Suppose you have Rs. 1,000 today. If you can put it in an account that pays 10% per year, after one year you'll have Rs. 1,000 plus 10% of Rs. 1,000 as interest. So after year 1 you have:

Interest = 1,000×0.10=100

Future value after 1 year = 1,100.

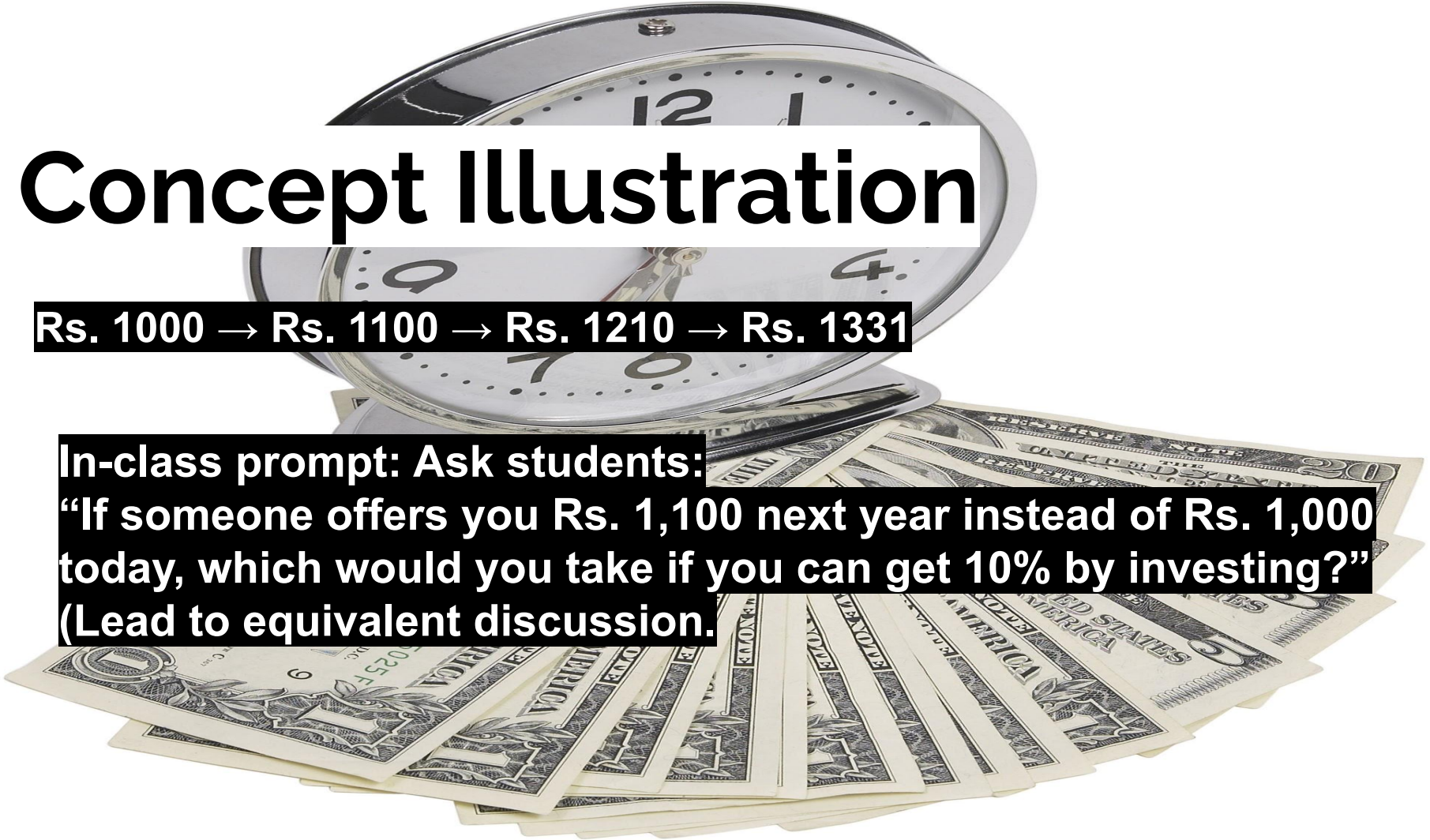
Time Value of Money (TVM)

If you leave it for another year at the same 10%, that next year's interest is earned on Rs. 1,100, not just on Rs. 1,000. So the amount grows to:

- **Interest in year 2 = $1,100 \times 0.10 = 110$**
- **Future value after 2 years = $1,100 + 110 = 1,210$**.

And so on. This is the basic idea of compounding: interest on interest.

Concept Illustration



Rs. 1000 → Rs. 1100 → Rs. 1210 → Rs. 1331

In-class prompt: Ask students:
“If someone offers you Rs. 1,100 next year instead of Rs. 1,000 today, which would you take if you can get 10% by investing?”
(Lead to equivalent discussion.

Interest Rate Defined

Lecture script (detailed):

“Interest rate (i) is the rate at which money grows per period (usually per year).

It is the price of money — what you pay to borrow, or what you receive when you lend/invest.

i=interest in one period/Principal at start of period

Example

Example (worked):
If P=5,000 and i=8%=0.08

- **Interest in 1 year = 5,000×0.08=400.**
- **Value after 1 year = 5,000+400=5,400.**

Class prompt: “Name some reasons why interest rates differ between banks, countries, and types of loans.”

Simple vs. Compound Interest

Type	Formula	Example
Simple	$I = P \times i \times n$	Rs. 1000×10%×2=Rs.200
Compound	$F = P(1+i)^n$	Rs.1000×$(1.1)^2$=Rs.1210

Simple

Simple interest: Interest is calculated only on the original principal every period.

- ***Formula: $I=P\times i\times n$***
- ***Final amount: $F=P(1+in)$***

  Worked example: $P=10{,}000$, $i=5\%=0.05$, $n=3$

- **Interest = $10{,}000\times0.05\times3=10{,}000\times0.15=1{,}500$**
- **Future amount = $10{,}000+1{,}500=11{,}500$**

Compound

Compound interest: Interest in each period is added to principal, and next period's interest is earned on the new amount (interest on interest).

- **Formula: F=P(1+i) power n**

Example

Worked example: same numbers:

- Year 1: $10{,}000 \times 1.05 = 10{,}500$
- Year 2: $10{,}500 \times 1.05 = 11{,}025$
- Year 3: $11{,}025 \times 1.05 = 11{,}576.25$
- So $F = 10{,}000 \times (1.05)3 = 11{,}576.25$

Compounding Over Time

Yearly

Quarterly

Monthly

More compounding → More return

Compounding Over Time

“If interest is quoted as an annual nominal rate but compounded more frequently, the effective rate per year increases.

If nominal annual rate is r and compounding is m times per year, the periodic rate is i=r/m

After one year, the accumulated value of Rs. 1 is: (1+r/m) power m

Compounding Over Time

Worked example: $r = 12\% = 0.12$

- Annual compounding ($m = 1$): $(1 + 0.12)^1 = 1.12$
- Semi-annual ($m = 2$): $\left(1 + \frac{0.12}{2}\right)^2 = (1 + 0.06)^2 = 1.06^2 = 1.1236$
- Quarterly ($m = 4$): $(1 + 0.03)^4 \approx 1.1255$
- Monthly ($m = 12$): $(1 + 0.01)^{12} \approx 1.1275$
- Continuous: $e^{0.12} \approx 1.1275$ (similar to monthly)

Future Worth (FW)

F=P(1+i) power n

Example: Rs. 10,000 at 8% for 3 years → Rs. 12,597

Present Worth (PW)

P= F divided by (1+i) power n

Find present value of Rs. 12,000 to be received after 2 years at 10% per year."

Example: You'll get Rs. 12,000 after 2 years, interest 10% → PW = Rs. 9,917

Present Worth (PW)

“If someone offers Rs. 9,950 today or Rs. 12,000 after 2 years and market rate is 10%, which is better?” (Compute PW of Rs.12,000 = 9,917.36 → Rs.9,950 today is better.)

Timeline Visualization

“Always draw a timeline. Put years (or periods) on the horizontal axis. Mark cash inflows as + and outflows as – at their respective times.

Example timeline:

- **Year 0: –Rs. 10,000 (investment)**
- **Year 1: +Rs. 3,000**
- **Year 2: +Rs. 4,000**
- **Year 3: +Rs. 5,000**

Activity 2: TVM Practice

Find Future Value of Rs. 5000 at 12% for 4 years.

Show working together on notebooks

Graph: Growth of Rs. 1

Show Rs. 1 becoming Rs. (1+i)^n with time.

Concept Check

If the interest rate doubles, what happens to future value?

Interactive discussion.

Real Example: Student Loan

Borrow Rs. 200,000 at 8% interest.
How much to repay after 3 years?

Compute together.

Economic Decision Thinking

Now we can compare money at different times — foundation for economic equivalence.

Mini Quiz

Q1: What does “n” stand for?

Q2: What is PV of Rs. 1000 after 1 year at 10%?

Recap Summary: TVM

Time changes money's value

Compounding grows value

Discounting reduces value

1.3 Economic Equivalence

1.3 Economic Equivalence

Two cash flows are economically equivalent if they have the same value when compared at the same point in time.

Why Equivalence Matters

To compare:

- **Different options**
- **Different durations**
- **Different payment methods**

Example: Salary Choices

Rs. 100,000 today
B: Rs. 115,000 next year at 10%
→ Which is better?

Example: Loan Repayment

Rs. 500,000 now or Rs. 275,000 per year × 2 years at 10%
Which option is equivalent?

Example: Car Purchase Plan

Car cash = Rs. 3,000,000
Installments: Rs. 650,000 for 5 years
Find equivalent PV.

Example: Machine Replacemen

Machine A: Rs. 800,000, Rs. 150,000/year maintenance

Machine B: Rs. 1,000,000, Rs. 100,000/year maintenance

Use EUAC to compare.

Case Study: Software Development

To understand how the concept of *economic equivalence* helps software engineers make informed financial decisions — such as whether to build, buy, or maintain a software product — based on the *time value of money* and *cost-benefit analysis*.

Concept Recap

Economic equivalence means that two or more cash flow options have the same present worth, even if their *timing* or *structure* differs.

In software projects, this concept helps compare:

- **Development vs. Outsourcing**
- **Upgrading vs. Replacing systems**
- **Subscription-based vs. One-time purchase models**

In-House Development vs. Outsourcing

Option	Description	Cash Flow (Rs.)	Time
A – In-House Development	Internal team develops system	-2,000,000 (initial cost)	Year 0
	Maintenance cost per year	-400,000 per year	Years 1–4
B – Outsourcing	Vendor develops and maintains	-1,200,000 (initial)	Year 0
	Annual payment to vendor	-600,000 per year	Years 1–4

Cloud Subscription vs. On-Premise License

Buy software license for Rs.3,000,000 (one-time) + Rs.200,000/year maintenance.

Use cloud version for Rs.900,000 per year (subscription).
Find which is better over 4 years at 8% interest.

Activity for Students

Scenario:
Your startup needs a project management tool.
Two options:

Option	Cost Type	Cost (Rs.)	Duration
A	Buy Jira Server	-500,000 (initial) + -100,000/year maintenance	3 years
B	Jira Cloud	-220,000/year	3 years

Task:

At 10% interest rate, calculate the **present worth** of each option and decide which is economically equivalent (cheaper).

- Work in pairs.
- Present reasoning, not just calculations.

Then discuss:

“If the interest rate changes to 5%, does your decision change?”

Common Mistakes by Beginners

- Ignoring time value
- Comparing future with present directly
- Using wrong interest rates