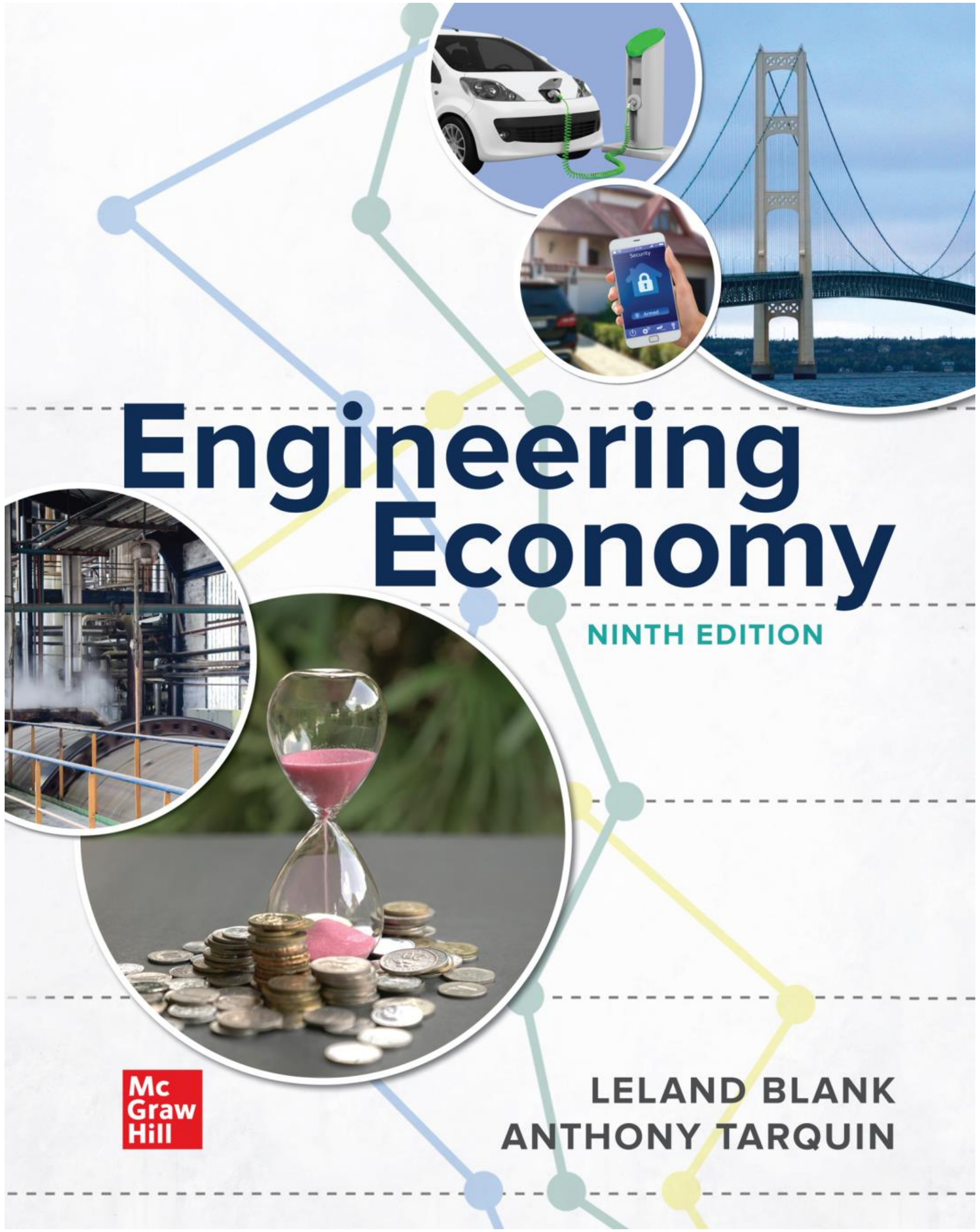
THE UNIVERSITY OF BRITISH COLUMBIA

School of Engineering
Okanagan Campus

ENGR 544, Life Cycle Assessment and Management

School of Engineering, Faculty of Applied Science

The University of British Columbia (Okanagan)


Engineering
Economy
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Foundations of Engineering Economy

1. Economics role in decision making
2. Study approach
3. Ethics and economics
4. Interest rate and rate of return
5. Terms and symbols
6. Cash flows
7. Economic equivalence
8. Simple and compound interest

Economics role in decision making

1. Why Engineering Economy is Important to Engineers

- Engineers design and create
- Designing involves economic decisions
- Engineers must be able to incorporate economic analysis into their creative efforts
- Understanding and applying time value of money, economic equivalence, and cost estimation are vital for engineers
- Project decisions are made more on the return on investment or payback than on technology
- You must communicate the basics of economy for your proposals to get funding

Time Value of Money (TVM)

TVM explains the **change** in the **amount of money** over time for funds owed by or owned by a corporation or individual

- **Corporate investments are expected to earn a return.**
- **Investment always involves money.**
- **Money has a ‘time value’.**

The time value of money is the most important concept in engineering economy

$1 Million	$1 Million	$1 Million
2004	**2014**	**2024**

Engineering Economy

Engineering Economy involves

- **Formulating**,
- **Estimating**, and
- **Evaluating**

expected economic outcomes of **alternatives** designed to accomplish a defined purpose

Projects	**A**	**B**
Income	Monthly	Annually
Periods	4 Years	7 Years

- Easy-to-use math techniques simplify the evaluation
- Estimates of economic outcomes can be deterministic or stochastic in nature

Interest rate and rate of return

Interest and Interest Rate

- **Interest** – the **indicator** 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

- **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

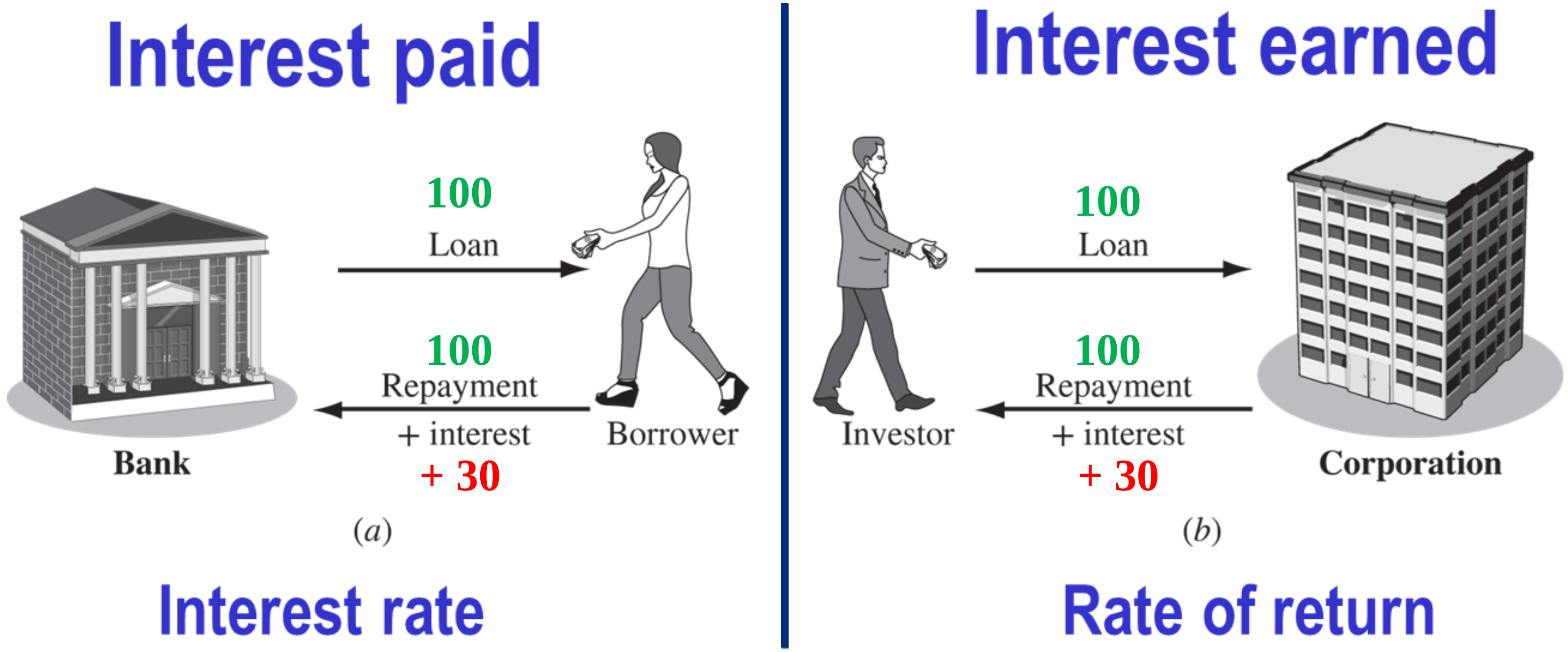
- Interest earned over a period of time is expressed as a percentage of the original amount (principal)

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

Borrower’s perspective – interest rate paid

Lender’s or investor’s perspective – rate of return earned

Depends on your point of view



Class Participation 21

Reese, a music lyricist, plans to borrow \$20,000 from a bank for 1 year at 9% interest to upgrade currently owned recording equipment. (*a*) Compute the interest and the total amount due after 1 year. (*b*) Construct a column graph that shows the original loan amount and total amount due after 1 year used to compute the loan interest rate of 9% per year.

???

Inflation and Purchasing Power

Inflation – Decreases the value of money

$100 now buys less than some time ago

Increases interest rates on loans

Lowers rate of return on investments

Purchasing power – Also called buying power; a bad companion of inflation

Increases in inflation lower purchasing power

$12 for burger fries and drink **last year,** ***now*** buys only the burger and fries

Terms and symbols

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

Example: Use of Symbols

Problems will always involve at least 4 of the symbols with one of them unknown

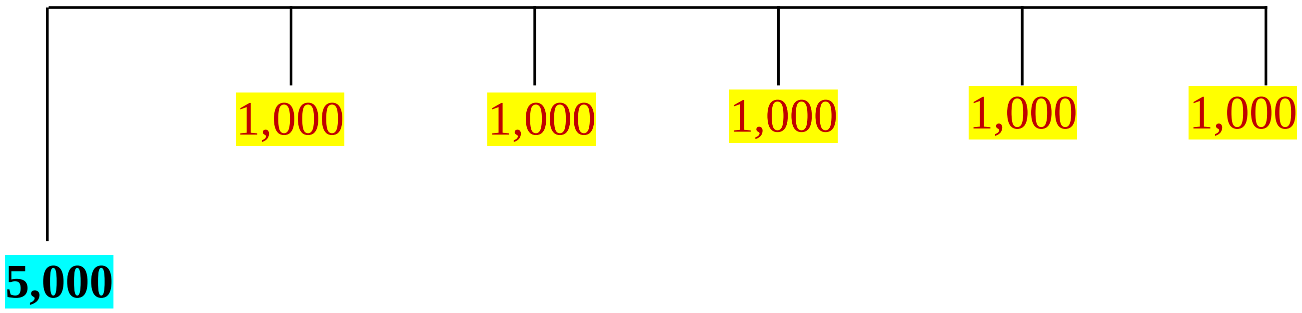
Invest \$5000 now plus \$1000 every year thereafter for 5 years. At i = 6% per year, find future value after 6 years.

P = \$5000 i = 6%

A = \$1000 in years 1, 2, 3, 4, and 5

F = ? after 6 years

n = 5 for A series and 6 for F value



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:

$$\text{NCF} = \text{cash inflows} - \text{cash outflows} = R - D$$

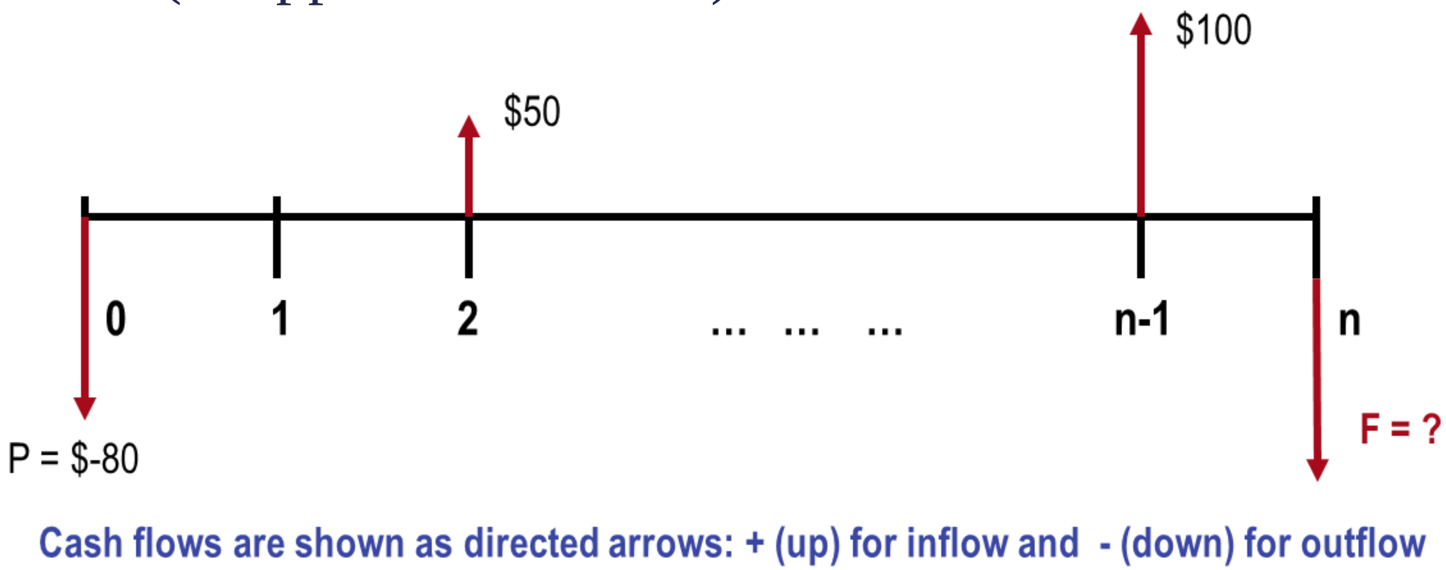
End-of-period assumption:

Funds flow at the end of a given interest period

Cash Flow Diagrams

- What a **typical cash flow diagram** might look like
- Draw a time line

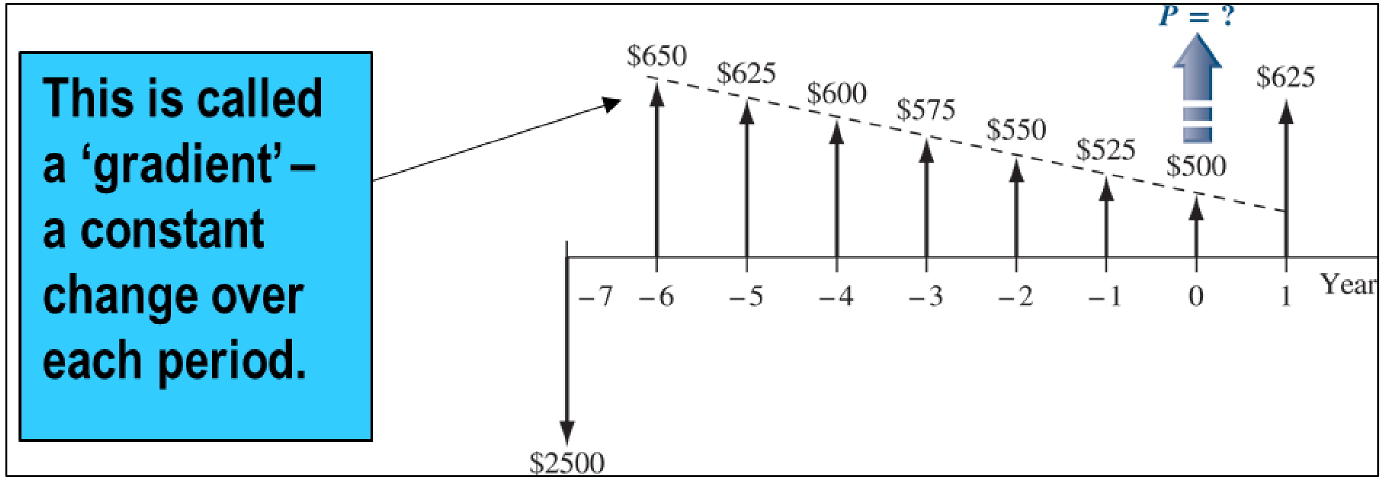
- Show the cash flows (to approximate scale)



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, $t = 0$

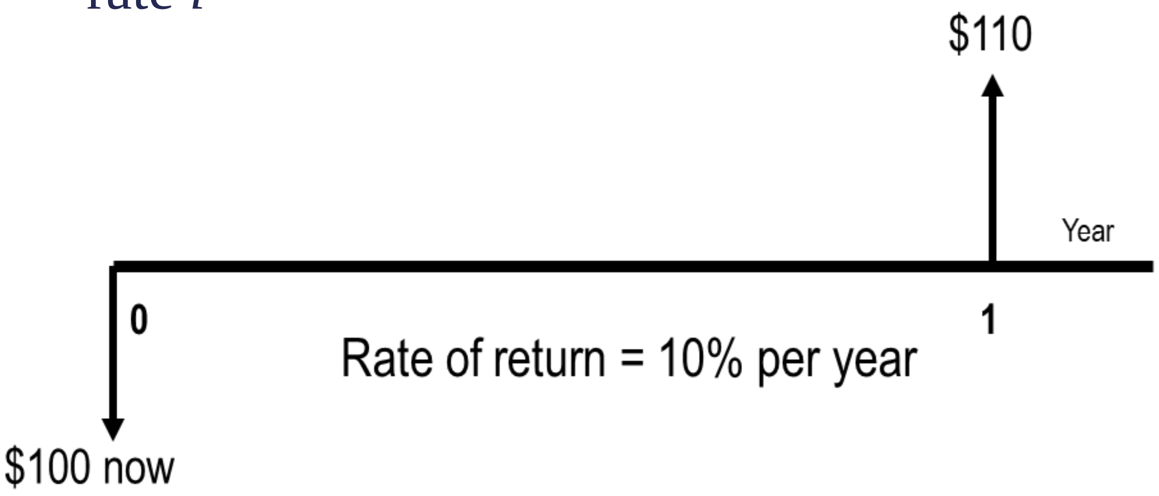
End of Year	Income	Cost	Net Cash Flow
−7	$0	$2500	$−2500
−6	750	100	650
−5	750	125	625
−4	750	150	600
−3	750	175	575
−2	750	200	550
−1	750	225	525
0	750	250	500
1	750 + 150	275	625



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 interest rate *i* and time *t* in upcoming relations to move money (values of *P*, *F* and *A*) between time points *t* = 0, 1, . . ., *n* to make them equivalent (not numerically equal) at the rate *i*



$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 and Compound Interest (1)

- Simple Interest

- Interest is calculated using principal only

$$\text{Interest} = (\text{principal})(\text{number of periods})(\text{interest rate})$$

$$I = Pni$$

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

$$\text{Interest} = 100{,}000(3)(0.10) = \$30{,}000$$

$$\text{Total due} = 100{,}000 + 30{,}000 = \$130{,}000$$

Simple and Compound Interest (2)

Compound Interest

- Interest is based on principal plus all accrued interest.
- That means interest ***earns*** interest and **compounds over time**.

$$\text{Interest} = (\text{principal} + \text{all accrued interest})(\text{interest rate})$$

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 borrowed for 3 years at i = 10% per year compounded. What is the repayment amount after 3 years?

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

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

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

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

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

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

Compounded: \$133,100

Simple: \$130,000

General Equation for Compounding

Determine the total amount due after *n* years using the equation:

$$\begin{aligned}\text{Total due} &= (\text{principal})(1+\text{interest rate})^{n} \\ &= P(1+i)^{n}\end{aligned}$$

For previous example with 10% compounded interest,

$$\begin{aligned}\text{Total due} &= 100{,}000(1.10)^{3} \\ &= 100{,}000(1.331) \\ &= \$133{,}100\end{aligned}$$

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