

Chapter 1 Foundations of Engineering Economy

- **What is Engineering Economy?**
 - It involves estimating, formulating and evaluating the financial outcomes of alternatives
 - It is a collection of mathematical techniques that simplify economic comparison
 - It provides a criteria for decision making
- **Steps of a decision making process**
 1. Understand the problem and define the objective
 2. Collect relevant information
 3. Define alternatives and estimate relevant costs
 4. Identify the criteria
 5. Evaluate each alternative
 6. Select the best alternative
 7. Implement the solution
 8. Monitor the results
 9. Refine the solution (go back to 3)

Use Eng. Econ.

¹ Notes are extracted and adopted from notes of Prof. Bacel Maddah (AUB)

- **Operations Research**

- OR is also concerned with scientific decision making.
- It utilizes advanced math, stats, algorithms, software, and other tools, for rigorous analysis.
- It is suited for complex systems and critical decisions.
- Engineering economy concepts are at the heart of the OR analysis.
- ENMG 500, 501 and many of the EM graduate courses fall under the wide umbrella of OR.

- **Why Eng Econ is important to engineers?**

- Engineers “design” and create
- Designing involves economic decisions
- Engineers must be able to incorporate economic analysis into their creative efforts
- Often engineers must select and execute from multiple alternatives
- A proper economic analysis for selection and execution is a fundamental aspect of engineering

- **Examples of questions Eng Econ can answer**
 - Replace an old equipment?
 - Introduce a new product?
 - Build a new plant?
 - Invest in project A or in project B?

- **Time Value of Money**
 - \$1 today is not “equivalent” to \$1 a year later. Worst alternative is to deposit (invest) the \$1 in a bank and gain “interest” (or dividend)
 - *“Money makes money”*
 - All firms make use of investment of funds
 - Investments are expected to earn a return
 - Investment involves money
 - Money possesses a “time value”

- **Interest**
 - Interest is the manifestation of the time value of money
 - Rental fee that one pays to use someone else’s money
 - Difference between an ending amount of money and a beginning amount of money
 - Interest rate = (interest accrued per time unit) / (original amount)

- From the lender perspective, the “earned” interest rate is a “rate of return” (ROR)

$$\text{Interest rate (\%)} = \frac{\text{Final loan amount} - \text{Original amount borrowed}}{\text{Original amount}} \times 100$$

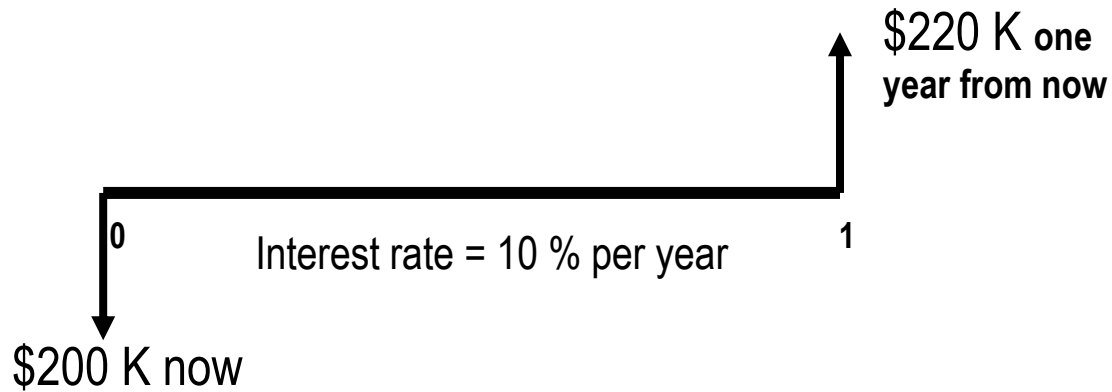
$$\text{ROR (\%)} = \frac{\text{Final investment value} - \text{Original amount invested}}{\text{Original amount}} \times 100$$

- **Interest Examples**

- The Oracle investment group invested \$200,000 on May 1 and withdrew a total of \$220,000 exactly one year later
 - Interest earned = \$220,000 – \$200, 000 = \$20,000
 - ROR = (\$20,000 / \$200,000) × 100 = 10%
- Another Oracle group borrowed \$100,000 on May 1 and paid a total of \$105,000 exactly one year later
 - Interest paid = \$105,000 – \$100, 000 = \$5,000
 - Interest rate = (\$5,000 / \$100,000) × 100 = 5%

- **Equivalence**

- Different sums of money at different times may be “equivalent” in economic value.
- For the Oracle group doing the investment, \$200 K now are equivalent to \$220 K a year later



- **Equivalence Example**

- You want to replace your study desk. The new desk is now \$125 and estimated to be worth \$135 for the next year.
- At a market interest rate of 12%, would you replace your desk now or the next year?
- \$135 next year are equivalent to $135/1.12 = \$120.54 < \125 .
- Then, it's better to buy the desk next year because this saves you around \$5.
- This is a "Present Worth" analysis

- **Simple and Compound Interest**

- Interest can be either simple or compound.
- With simple interest, in each period one pays interest on the principal (the amount borrowed) itself only

- With compound interest, in each period, one pays interest on the principal and on the interest accumulated from previous periods.
- That is, one pays “interest on interest”
- Suppose you borrow an amount P and pay interest for n years at a rate of i per year.
- Then, the amount, F , you pay back n years later is

- With simple interest,

$$F = P + iP + \dots + iP = P + niP.$$

Then, $F = P(1 + ni)$

- With compound interest,

$$F = P(1 + i)(1 + i) \cdots (1 + i).$$

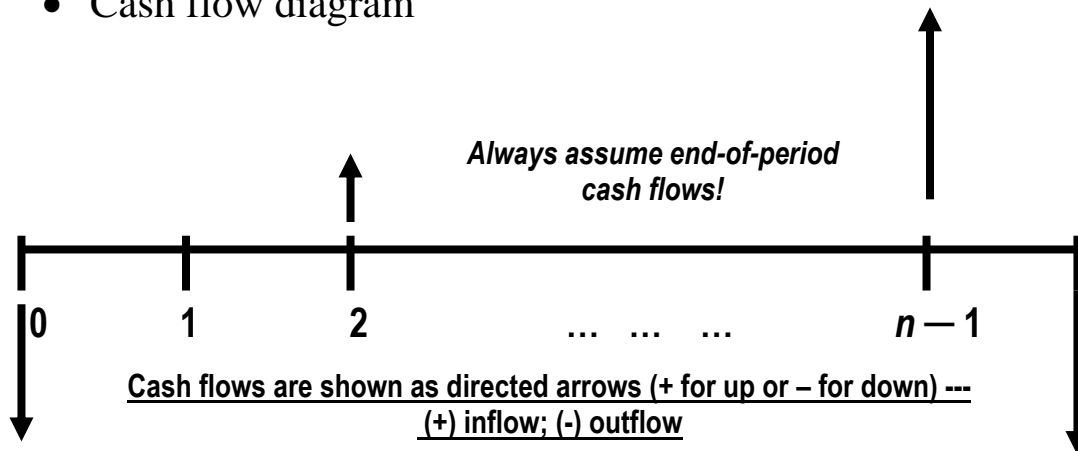
Then, $F = P(1 + i)^n$

- **Cash Flows**

- Cash Inflows - amount of funds flowing into the firm
- Cash Outflows – amount of funds flowing out of the firm
- Example of cash inflows
 - Sales Revenue
 - Asset salvage value
 - Borrowed money
 - Income tax savings

- Example of cash outflows
 - Paybacks
 - Labor cost
 - Maintenance and operating costs
 - Loans (from the lender's perspective)
 - Income taxes

- Cash flow diagram



- **Minimum Attractive Rate of Return (MARR)**
 - Investors expect to earn a return on their investment (commitment of funds) over time
 - Economic projects should earn a reasonable return, which is termed “minimum attractive rate of return” (MARR)
 - The company management establishes the MARR

- MARR is estimated based on the weighted average of the “cost of capital” of sources of funding available to the firm (simply termed cost of capital for the firm).
- Sources of funding can be
 - Equity financing – the firm uses its own assets to finance often through issuing stocks.
 - Debt financing – the firm borrows money to finance often through issuing bonds.
- MARR is set in such a way that $\text{MARR} > \text{cost of capital}$
- To be considered financially viable, a project’s expected ROR must meet or exceed the MARR. That is, a project should be undertaken if and only if its $\text{ROR} \geq \text{MARR}$
- **Rule of 72**
 - This rule (approximately) estimates the number of time periods, n , it takes for an amount of money to double under a ROR of i (%)

$$n = \frac{72}{i}$$