Engineering Economy (Introduction, Basic Economic Concepts, Interests Rate and Factors)

Nan Tu PhD

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Tsinghua University
Department of Industrial Engineering

Agenda

- Welcome
- Introduction of the instructor, TA
- Syllabus, **Grading**, Assignment, Exam, etc
- Introduction
- Interests Rate
- P, F, A, I, n etc.
- Cash flow diagram

Instructor: Nan Tu PhD

BS. Xi'an Jiaotong University, China

Manufacturing Engineer, 1990 – 1993 Yunnan, China

Adv. Manufacturing Engineer, 1996 – 1998 Seagate Technology, Inc. USA

Research Assistant, 1998 – 2001 University of Minnesota

MS, PhD, University of Minnesota, USA 2002

Visiting Scholar / Researcher, 2004 Microsoft Research Asia, Beijing, China

Lecturer, 2004 Tsinghua University

Various startup activities

Email: nantu@mail.tsinghua.edu.cn

Office: 6277-2426

Web: http://www.drtu.com

Teaching Assistant: 王培

Responsibilities:

- Home work and project questions
- Communicate with team leaders
- Help with grading

Email: pei-wang05@mails.tsinghua.edu.cn
Dorm Phone: 5153-3637

Class Rules

- Attendance (you are **expected** in each class)
- Participation (I **encourage** class discussion)
- Cell phone:- **turn off or use vibration**
- Ethics (you are expect to produce your **own** work)
- **Electronic** version home work submitted through Net Classroom (网路学堂）(no paper, no late assignment accepted, no exceptions)

Engineering Economy Syllabus

Textbook: Leland Blank and Anthony Tarquin, Engineering Economy, McGraw Hill, 5th Edition, ISBN 0-07-243234-9

Schedule

Grading

One large assignment which requires comprehensive knowledge of the course material- 20%,

Homework / Reading assignments- 40% (please submit the electronic version to 网络学堂, No paper version accepted)

Project- 40% (work with teams, 7 person at each team, include manager, liaison, writer, researcher/data collector, mathematician, presenter, etc)

Please refer to the handout

What do Industrial Engineers do?

- Industrial engineers make things **work better**, more safely, and more economically.
- Improve **Efficiency**
- **Reduce** Waste
- Industrial Engineering principle has been applied to many disciplines

http://www.iienet.org

Engineering Economy Class

What do we learn?

Formulating, estimating, and evaluating economic outcomes of alternatives designed to accomplish a specific purpose

Course Objectives

- Understanding of the "time value of money" concept.
- Ability to apply interest equations to equivalence calculations.
- Ability to apply various methods for economic analysis of alternatives.
- Basic understanding of depreciation for typical engineering projects.
- Ability to develop project cash flows for design alternatives and perform calculations using **Microsoft Excel**.
- Ability to make replacement decisions.
- Basic understanding of project risk and uncertainty using sensitivity and break-even analyses.
- Basic understanding of inflation and its impact on engineering economic decision-making.

Engineering Economy Can Make Money For You

- A University of Minnesota, Industrial Engineering graduate who owns 100 + Burger King chain stores said: Engineering Economy is one of the most useful course that he learned in school.
- I agree. I have applied it to various startup business and my personal finance
- Here is a real estate investment example

从97到04年美国的房地产投资的回报都很高，以下是一个美国中部地区的投资实例，47。5%的回报 (I) Return on Investment, real estate example in the US, 47.5% return from 97-04

- 房产**97底年价格 (purchasing price)**：120，000美元
  - –30 % 预付底金 (down payment)， 36，000美元
  - –70% 银行贷款 (bank loan)，84，000美元
  - –买房时的手续费等(transaction cost)：2000美元
  - –共投资 (total investment)：38，0000美元
- 成本 **(cost)**：
  - –年利 (Interest rate)：7%，三十年fixed，月供：567美元
  - –地产税 (property tax)：80美元/月
  - –保险 (insurance)：80美元/月
  - –房管公司 (property management fee)：月租金的7%，约100美元/月
  - –维修和整理(maintenance)：50美元
- 收入**(revenue)**：
  - –出租月入(rent)：1400美元/月
  - –出租率(occupancy)：90%
  - –现金流(cash flow)：1260—567-80-80-90-50= 393美元/月= 4716美元/年

从97到04年美国的房地产投资的回报都很高，以下是一个美国中部地区的投资实例，47。5%的回报 (II)

- **回报不考虑升值 (ROI without appreciation)**：4716/38000 = 12。4%（不高）
- 但是(but the property is sold in 2004)：此房在2004年一月卖了210，000美元，除去房屋中介的佣金及其他杂费，净得200，000美元，6年时间净盈利：80，000美元，每年净得：13333美元

- **回报考虑升值(new ROI with appreciation)**：18049/38000 = 47。5%（您看高不高）

- 此例特点是：风险很小，基本不用业主干任何活。也不需要业主有任何投资经验。Low risk, not too much work for the investor, no experience required.

- 当然还有很多增加投资回报率的办法，比如：减少预付底金等。There are many other ways to improve ROI, please give me some examples.

Class Discussion

- Give me an example of how do you increase ROI for the previous example.

Engineering Economy

- Use of mathematical techniques to simplify economic comparisons
- Assist people in making decisions about the future
- Must make estimates of:
  - **Cash flows**
  - **Time of occurrence**
  - **Interest rates**
- Perform **sensitivity analysis** to determine the impact on the outcome of varying estimates

The Decision Making Process

- Understand the problem and define the objective
- Collect relevant information
- Define the feasible alternative solutions and make realistic estimates
- Identify the criteria for decision making using one or more attributes
- Evaluate each alternative, using sensitivity analysis to enhance the evaluation
- Select the best alternative
- Implement the solution and monitor the results

The Time Value of Money

- Definition: The change in the amount of money over a given time period. This is the most important concept in engineering economy

Performing an Engineering Economy Study

- Alternative Description
- Alternative Selection

Alternative Description

- Understanding what the problem requires for solution.
  - Stand-alone options as possible alternatives
  - Cash Flows—Estimates of first cost, annual income and expenses, salvage value, interest rate, inflation, and income tax effect

Alternative Selection

Definition: the measure-of-worth values are compared and an alternative is selected.

- **Often one alternative is the "do-nothing" approach—status quo**
- **Financial analysis** — generally used as the tangible basis for evaluation. Selection the option with lowest overall cost or highest net income.
- **After-Tax Analysis** — generally used to account for asset depreciation and income taxes. Can either improve or reduce cash flows.

Interest Rate and Rate of Return

- Interest Rate (i) The manifestation of the **time value of money**
  - The difference between an ending amount of money and the beginning
  - Necessary to state whether the interest is accrued on a simple or compound basis from one period to the next.
  - Interest period—the time unit of the rate. Generally 1 year
- **Rate of Return** (ROR) — interest paid/earned over a specific period of time, expressed as a percentage of the original amount
- **Return on Investment** (ROI) — the same as ROR, but generally used where large capital funds are committed to engineering-oriented programs.

Inflation

- General increase in the average price level
- From the borrower's perspective, inflation is another interest rate tacked on to the stated interest rate.
- From the saver/investor perspective, inflation reduces the real rate of return on an investment.
- Inflation can materially contribute to changes in corporate and personal economic analysis.
- Generally assume that inflation affects all estimated values equally.

Economic Equivalence

- Given different time value of money and interest rates, this means that different sums of money at different times are of equal economic value.

Simple and Compound Interest

Simple interest—the future value of the principal from one year to another year. This assumes that the principal earns interest over a one-year period, and the interest is withdrawn, leaving the principal in tact.

Compound interest—The interest accrued for each interest period is calculated on the principal plus the total amount of interest accumulated in all previous periods. Earning interest on previously accrued interest.

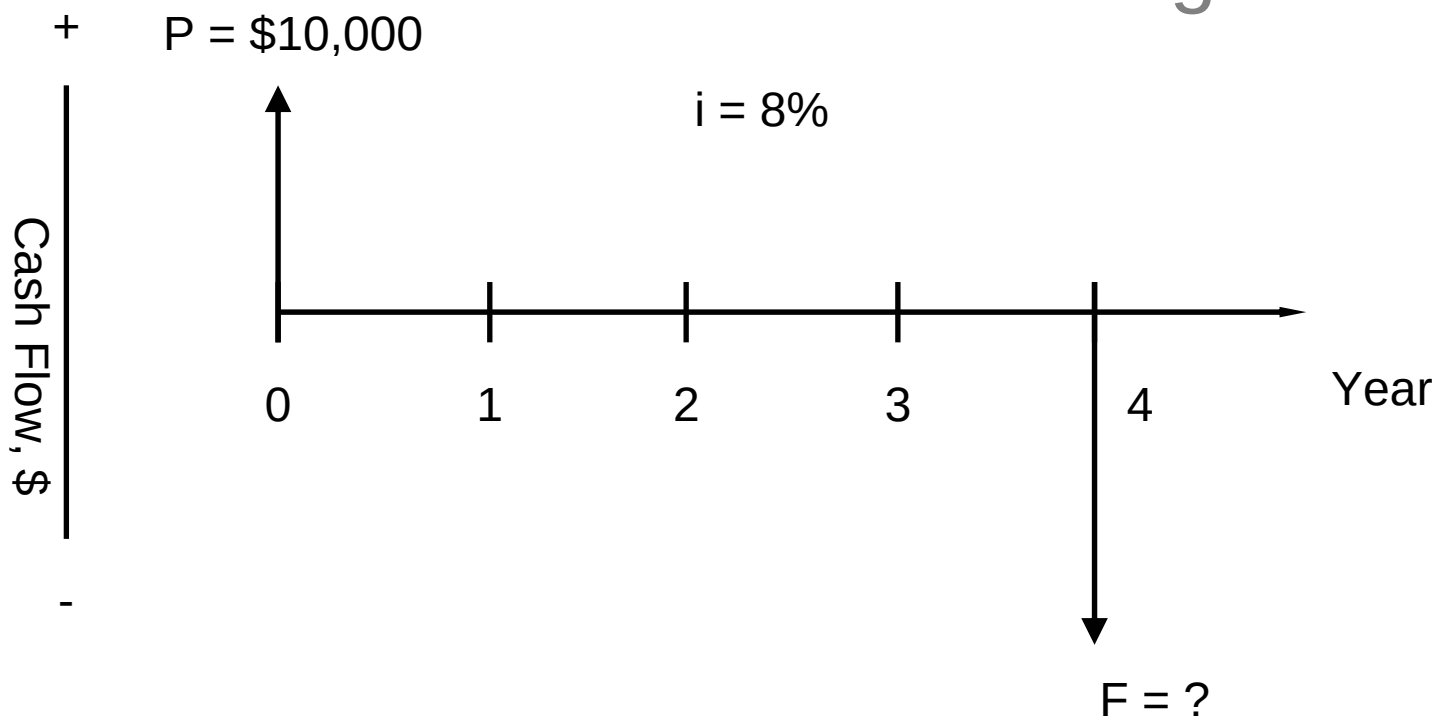
$$\textbf{Future Value} = \textbf{Principal}(1 + \textbf{interest rate})^{n}$$

Where “n” represents the number of years in the future

Terminology and Symbols

- **P** = Value or amount of money at the time designated as the present or time 0.
- **F** = Value or amount of money at some future time.
- **A** = series of consecutive, equal, end-of-period amounts of money. Must extend through consecutive interest periods.
- **n** = number of interest periods
- **i** = interest rate or rate of return per time period. Assumed to be compounded
- **t** = time, stated in periods

Cash Flow Diagram



- End-of-period convention — all cash flows (inflows – outflows) are assumed to occur at the end of an interest period.
- Time line — development of a time scale covering the expected life of the project
- Amount of cash flow—the net cash flow expected each period
- Direction of arrows—an upward arrow indicated a positive cash flow (inflow) and a downward arrow is a negative¬ (outflow).

Rule of 72

- Estimating Doubling Time and Interest Rate
- Using the following formula
- Estimated n = 72 / interest rate

  can calculate the approximate time required for an amount, compounded at a given rate (i) takes to double.

Single Payment Compound Amount Factor

- The future value of a single payment, in year n, made at the present time.

  $\mathbf{F = P(1 + i)^n}$

  $\mathbf{P = F/(1 + i)^n}$

  $$\mathbf{P = F}\left[\frac{1}{(1+i)^n}\right]$$

  Where:

  F = Future value

  P = single payment

  i = interest rate

  n = number of years into the future

Interest Rates and Different Years

- **Discrete** — Tables utilize the end-of-period convention
- **Interest**— Compounded once each interest period
- **Future value** — FV (i%,n,,P)
- **Present value** — PV (i%,n,,F)
  - **Note the double commas** (,,)

Notation	**Find / Given**	**Standard Notation Equation**	**Equation with Factor Formula**	**Excel Functions**
(*F/P,i,n*)	F/P	F=P(*F/P,i,n*)	$F=P(1+i)^n$	FV (*i%,n,,P*)
(*P/F,i,n*)	P/F	P=F(*P/F,i,n*)	$P=F[1/(1+i)^n]$	PV (*i%,n,,F*)

Home Work

None ☺