EM600 - Engineering Economics and Cost Analysis

Lecture 01: *Introduction to Engineering Economics*

- References:
  - Park, Chan S. Contemporary Engineering Economics. New Jersey: Pearson Prentice Hall, 2011 (Chapter 1)
  - Ganguly, A. Engineering Economics Using Excel. New Jersey: SSE, 2008

After completing this module you should understand the following:

- The objectives / overview of this course.
- What is engineering economics?
- Why study engineering economics?
- Types of decisions in engineering economics
- Limitations of engineering economics
- Fundamental principles of engineering economics
- Introduction: Excel in engineering economics

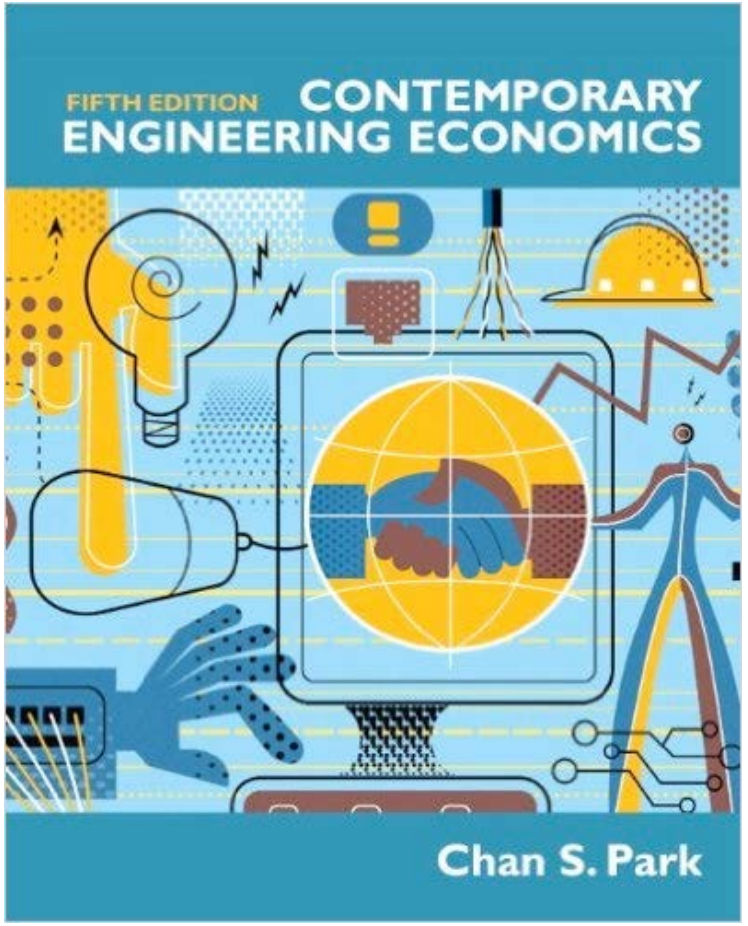
Items to review:

- Recommended text
- Schedule
- Class deliverables:
  - Homework assignments
  - Midterm exam
  - Final exam
  - Class Participation / Postings (web class)
- Grading scheme:
  - Point distribution
  - Submission policy

Items to review:

- Recommended text
  - Primary text:

    Park, Chan S. Contemporary Engineering Economics. New Jersey: Pearson Prentice Hall, 2011. ISBN 978-0-13-611848-0

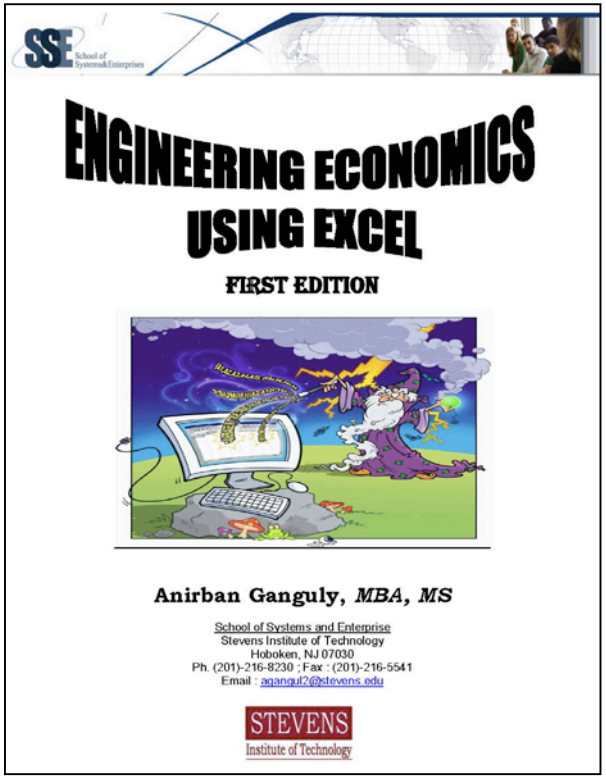


Items to review:

- Recommended text
  - Supporting text:

    Ganguly, Anirban. Engineering Economics Using Excel. New Jersey: SSE, 2008

    Electronic Version to be provided to the students.



Items to review:

- Recommended text
  - Additional resources:
    - Sullivan, W., Wicks, E., and Koelling, C. Engineering Economy. New Jersey: Pearson, 2015
    - White, Case and Pratt. Principles of Engineering Economic Analysis. New York: Wiley, 2012
    - Lang, Hans J. and Merino, Donald M. The Selection Process for Capital Projects. New York: John Wiley & Sons, Inc. 2002

Items to review:

- **Schedule: WEEK 1**
  - Lecture 01: Introduction to Engineering Economics
    - Primary Text: (Chan S. Park)
      - » Chapter 1
    - Topics:
      - » The objectives / overview of this course.
      - » What is engineering economics?
      - » Why study engineering economics?
      - » Types of decisions in engineering economics.
      - » Limitations of engineering economics.
      - » Fundamental principles of engineering economics.
      - » Introduction: Excel in engineering economics.

Items to review:

- **Schedule: WEEK 2**
  - Lecture 02: Understanding Cash Flow Diagrams, Interest Rates and Time Value of Money
    - Primary Text: (Chan S. Park)
      - » Chapters 3 & 4
    - Topics:
      - » Time value of money
      - » Cash flow diagram: basis, 'how to' and types (arithmetic, geometric gradient)
      - » Overview of simple and compound interests – calculation methods including continuous compounding
      - » Nominal, periodic and effective interest rates
      - » Equivalence calculations with nominal and effective interest rates
      - » Debt Management

Items to review:

- **Schedule: WEEK 3**
  - Lecture 03: Understanding the 3 Worths, Capitalized Cost and Capitalized Recovery
    - Primary Text: (Chan S. Park)
      - » Chapters 5 & 6
    - Topics:
      - » Three Worths: Present Worth, PW; Annual Equivalence, AE; Future Worth, FW
      - » Evaluation of Alternatives based on time value of money
      - » Capitalized Costs
      - » Capitalized Recovery
      - » Life Cycle Cost Analysis

Items to review:

- **Schedule: WEEK 4**
  - Lecture 04: Understanding Rates of Return
    - Primary Text: (Chan S. Park)
      - » Chapter 7
    - Topics:
      - » Return on Investment (ROI)
      - » IRR: Internal Rate of Return
      - » Incremental IRR
      - » Mutually Exclusive Alternatives

Items to review:

- **Schedule: WEEK 5**
  - Lecture 05: Benefit-Cost Analysis and its Implication for Public Sector Projects
    - Primary Text: (Chan S. Park)
      - » Chapter 16: 16.3 &16.4
    - Topics:
      - » Why Benefit-Cost Analysis (BCA) is used in Public Sector Projects
      - » Valuation of Benefits and Costs
      - » Definition of Benefit-Cost Ratio (BCR)
      - » Calculation of BCR (including Incremental BCR)

Items to review:

- **Schedule: WEEK 6**
  - Lecture 06: Depreciation and Financial Statements
    - Primary Text: (Chan S. Park)
      - » Chapter 9: 9.1 – 9.6
      - » Chapter 2: 2.2.2 – 2.2.3
      - » Chapter 10: 10.2
    - Topics:
      - » Overview of Depreciation
      - » Depreciable versus Non-Depreciable Assets
      - » Types of Depreciation
      - » Introduction to Income Statements
      - » Introduction to Cash Flow Statements

Items to review:

- **Schedule: WEEK 7**
  - Lecture 07: After Tax Analysis
    - Primary Text: (Chan S. Park)
      - Chapter 9: 9.7 – 9.10
      - Chapter 10: 10.3 & 10.4
    - Topics:
      - Corporate taxes
      - Treatment of capital gains and losses
      - Treatment of noncash expenses
      - After tax cash flow
        - Developing cash flow statements
        - Developing cash flow equations
        - Application of Excel to after tax analysis

Items to review:

- **Schedule: WEEK 8**
  - Lecture 08: Inflation
    - Primary Text: (Chan S. Park)
      - » Chapter 11
    - Topics:
      - » Introduction to Inflation
      - » Measuring / assessing inflation
      - » Equivalence calculation under inflation (real, constant, actual dollars)
      - » Impact of inflation on capital projects

Items to review:

- **Schedule: WEEK 9**
  - Lecture 09: Retirements & Replacements
    - Primary Text: (Chan S. Park)
      - » Chapter 14
    - Topics:
      - » Basic Concepts and terminologies
      - » Economic life
      - » Replacement analysis under different conditions
      - » Replacement analysis with after tax consideration

Items to review:

- **Schedule: WEEK 10**
  - Lecture 10: Cost Concepts and Capital Budgeting
    - Primary Text: (Chan S. Park)
      - » Chapter 8: 8.1 – 8.4
      - » Chapter 15
    - Topics:
      - » General cost concepts including the classification of costs / types of costs
      - » Introduction to capital budgeting
      - » Cost of capital
      - » Choice of MARR
      - » Capital budgeting decisions

Items to review:

- **Schedule: WEEK 11**
  - Lecture 11: Sensitivity Analysis
    - Primary Text: (Chan S. Park)
      - » Chapter 12: 12.1 & 12.2
    - Topics:
      - » Overview of break-even analysis
      - » Overview of sensitivity analysis
      - » Calculations and graphs used in sensitivity analysis
      - » Evaluating mutually exclusive alternatives using sensitivity analysis

Items to review:

- **Schedule: WEEK 12**
  - Lecture 12: Decision & Risk Analysis
    - Primary Text: (Chan S. Park)
      - » Chapter 12
    - Topics:
      - » Overview of project risk
      - » Introduction to probability concepts for investment decisions
      - » Probability distribution for NPW decision
      - » Comparing mutually exclusive risky alternatives
      - » Overview of risk simulation
      - » Overview of decision tree analysis in investment decisions

Items to review:

- **Schedule: WEEK 13**
  - Lecture 13: Introduction to Financial Accounting
    - Primary Text: (Chan S. Park)
      - » Chapter 2
      - » Chapter 8: 8.5
    - Topics:
      - » What is accounting?
      - » Importance of accounting to engineering and project managers
      - » Basic Accounting Terms and Concepts
      - » How financial data is used by investors, managers and others
      - » The structure of the four most important financial reports and how to use them
      - » Important financial ratios

Items to review:

– Class deliverables:

Date	Lecture	Homework Problems and Exams*	HW Review	In-Class Paragraph & Discuss
1/18	1	-	-	
1/25	2	-	-	X
2/01	3	-	-	X
2/08	4	HW #1 (Lectures 1, 2 and 3) Due	-	X
2/15	5	-	HW 1 Review	X
2/22	6	HW #2 (Lectures 4 and 5) Due	-	X
3/01	7		HW 2 Review	X
3/08	8	HW # 3 (Lectures 6 and 7) Due by 3pm	HW 3 Review	
		SPRING BREAK		
3/22	9	**Midterm Exam** (Lectures 1 – 7) **Due by 3pm**	-	
3/29	10	HW #4 (Lectures 8 and 9) Due	-	X
4/05	11		HW 4 Review	X
4/12	12	HW #5 (Lectures 10 and 11) Due	-	X
4/19	13		HW 5 Review	X
4/26	-	HW # 6 (Lectures 12 and 13) Due by 3pm	HW 6 Review	
5/10	-	**Final Exam** (Lectures 8 – 14) **Due by 3pm**		

Items to review:

- Grading scheme:
  - Point distribution

Homework assignments	25% (6 assignments)
Midterm exam	25%
Final exam	30%
Weekly discussion	20% (10 x 2%)

Items to review:

- Grading scheme:
  - Submission policy
    - PLEASE REFER TO THE CLASS SYLLABUS FOR FULL DETAILS.
    - THE FOLLOWING SLIDES SUMMARIZE SOME OF THE KEY POINTS TO BE NOTED.

Items to review:

- Grading scheme:
  - Submission policy
    - All assignments are due by the date and the time provided in the schedule.
    - The assignments can be faxed to the attention of Dr. Abel at (201)-216-5541, Emailed at kabel@stevens.edu. Do not leave assignments in Dr. Abel's mailbox located on the 5th floor of Babbio.
    - The Excel based assignments have to be submitted electronically only. Please make sure to put in your name and the problem number on your Excel spreadsheet, as well as, in the subject line of the email.

Items to review:

- Grading scheme:
  - Submission policy
    - The submission deadline will be followed strictly. Any submission beyond the stipulated deadline will result in a zero credit for that particular assignment.
    - Late homework submissions and make-up exams will be facilitated only if there is a situation of unavoidable emergency (for example, being hospitalized during the exam, serious illness during the exam or just before the exam, death in the family, etc.). This requires a written excuse and is solely based on the discretion of the instructor. If you do not submit a homework or take an exam, you will receive a zero for the corresponding submittal.

Course Objectives:

- Students will be exposed to the analysis of financial data the concept of interest rates and time value of money.
- Students will be able to make choices between alternative projects using a set of basic tools and techniques of engineering analysis, including the time value of money, internal rate of return and benefit cost ratio.

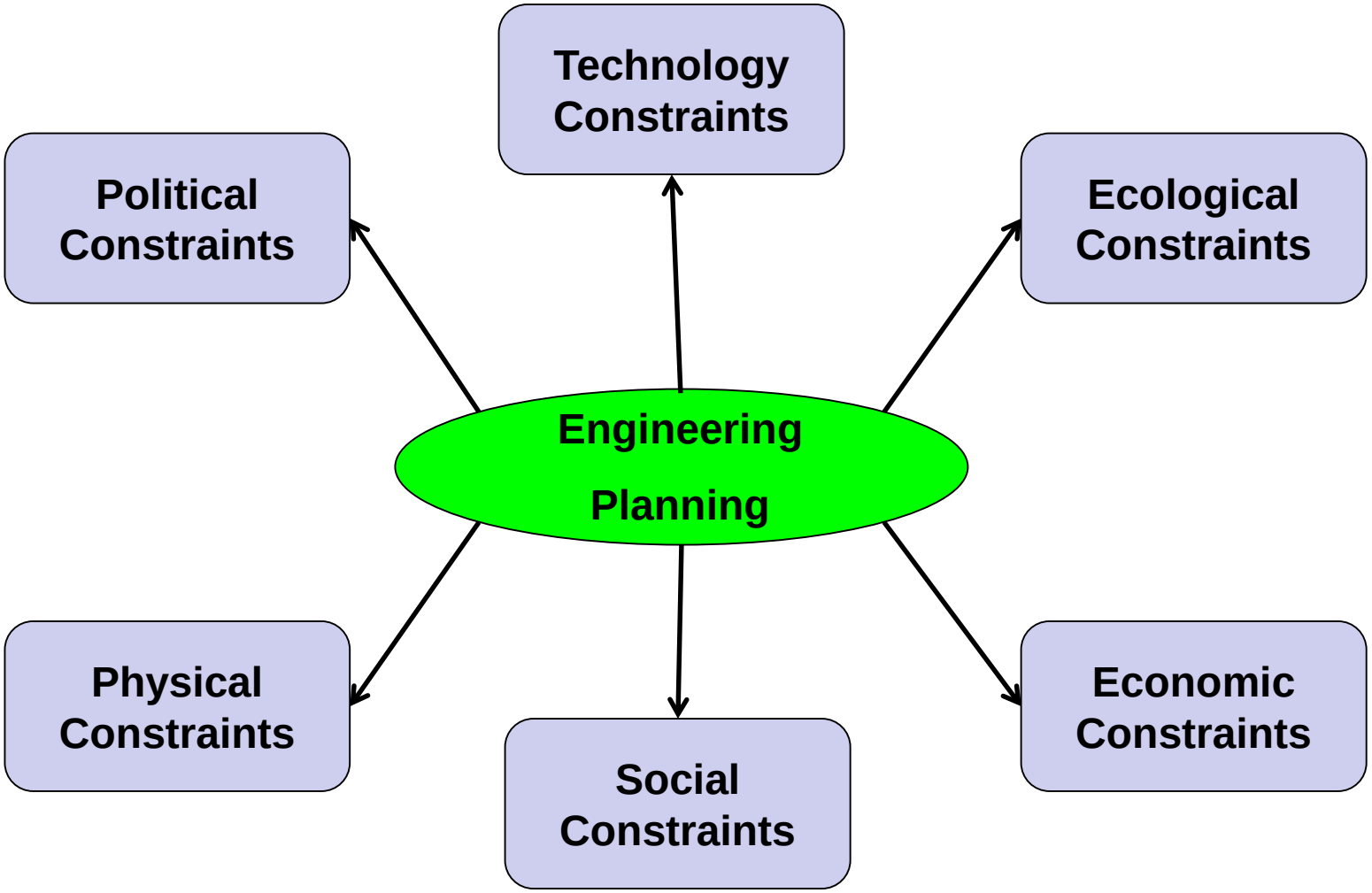
Course Objectives:

- Students will be able to gather a comprehensive knowledge about advanced engineering economics topics like depreciation of assets, after tax cash flows and inflation.
- Students will gain knowledge about important decision making tools like sensitivity analysis, risk analysis and simulation.

- Definitions:
  - *Engineering economics is the application of economic techniques to the evaluation of design and engineering alternatives.*[1]
  - *Engineering economics, … , is a subset of economics for application to engineering projects. Engineers seek solutions to problems, and the economic viability of each potential solution is normally considered along with the technical aspects.*[2]
- Key concepts:
  - *Estimating using economic techniques*
  - *Evaluating / choosing between alternatives*

1. ASTM Dictionary of Engineering Science and Technology (10th Edition). (pp. 214). ASTM International. Online version available at: http://www.knovel.com/knovel2/Toc.jsp?BookID=1741&VerticalID=0
2. en.wikipedia.org/wiki/Engineering economics

- Engineering Economics:
  - History at Stevens Institute of Technology
    - Alexander Crombie Humphries (ACH) became the 2nd president of SIT in 1902.
    - ACH brought with him extensive practical experience from industry.
    - ACH recognized the importance of a rounded engineering education that would incorporate aspects of finance such as accounting and economics.
    - ACH started the first business economics course at Stevens. This has developed into Engineering Economy courses both at the undergraduate and graduate level.
    - This foresight has resulted in Stevens Graduates becoming corporate executives (Verizon, Lucent, . . . etc) and successful entrepreneurs (GM, TI, . . . etc) over the years.


Technology Constraints
Political Constraints
Ecological Constraints
Engineering Planning
Physical Constraints
Social Constraints
Economic Constraints

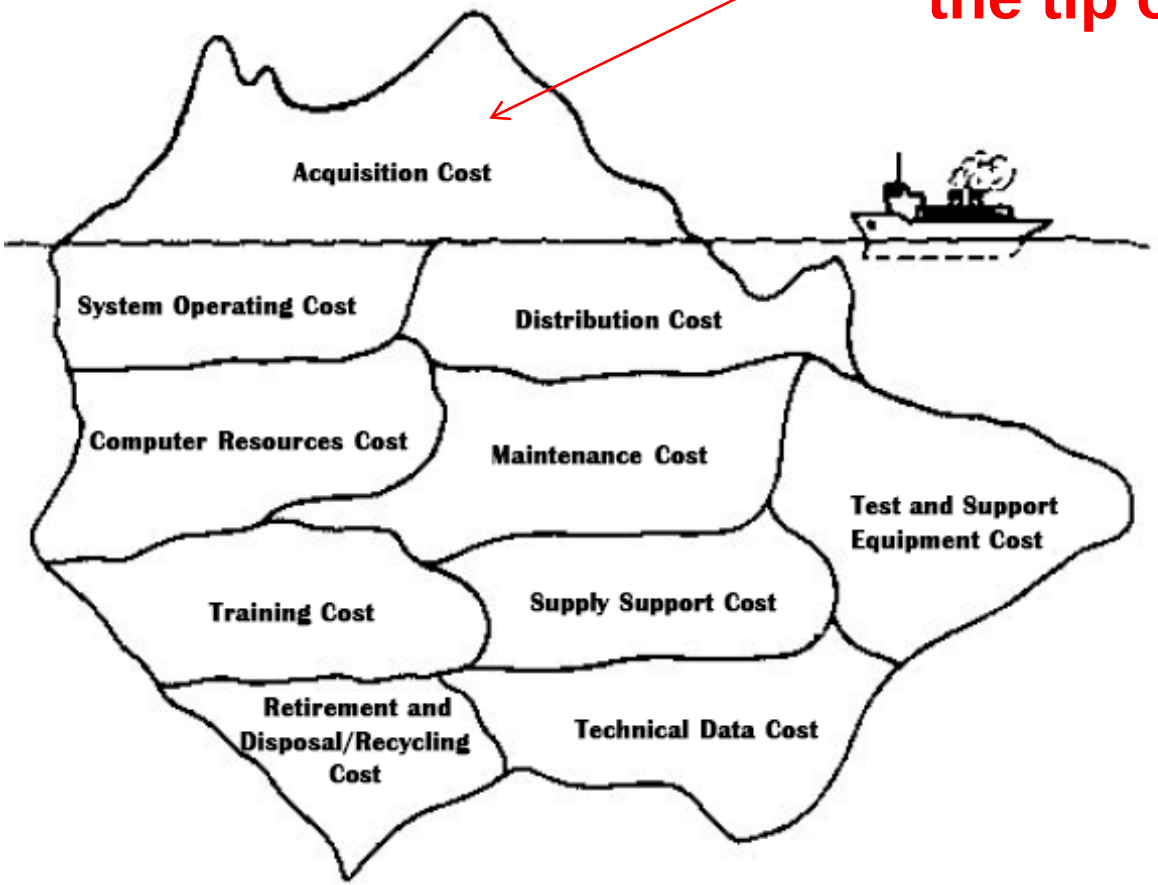
- Helps with real life personal decisions.
- Money matters.
- Projects require economic analysis to support engineering decisions.
- Different alternatives usually exist.
- Engineering Economics is NOT the only tool that should be used when evaluating a capital investment.
  - Risk
  - Reward
  - Time
  - Resources available

Why study Engineering Economics?

- Helps with real life personal decisions.

- Projects require economic analysis to support engineering decisions.

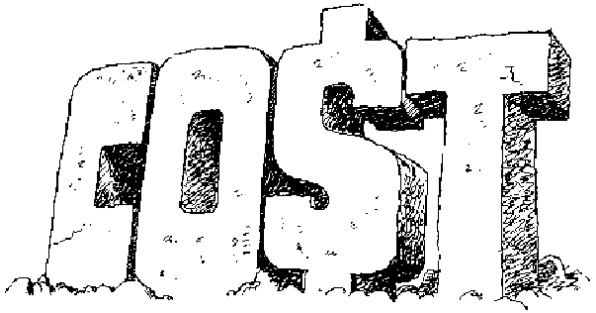
Acquisition costs are just the tip of the iceberg



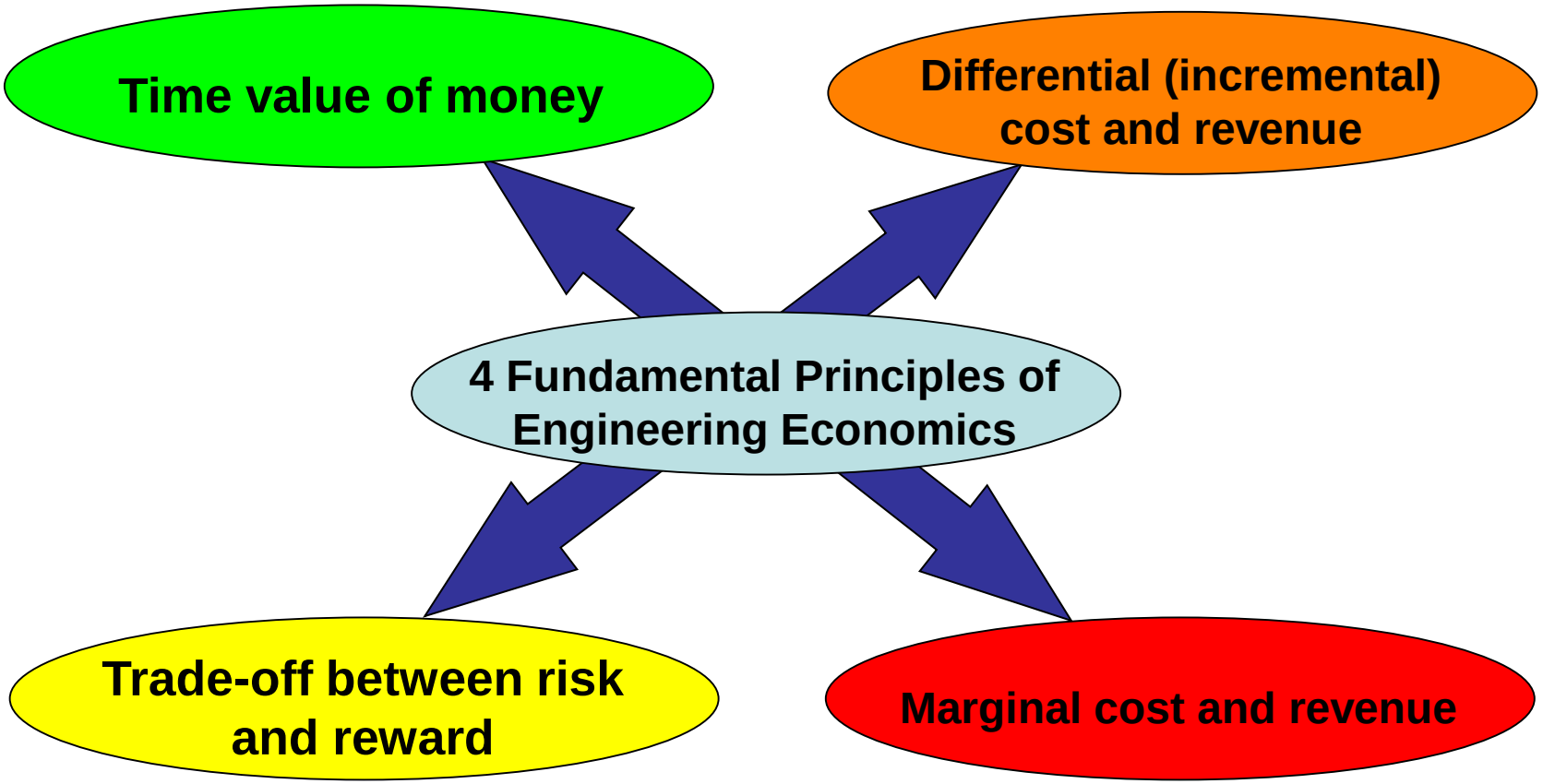
O&S Costs are typically the bulk of the iceberg

The Life Cycle Cost Iceberg
("Life cycle Cost and Economics Analysis" by Fabrycky & Blanchard)
http://www.rmspartnership.org/briefings/LOG203-1.pdf

- Typical decisions in engineering economics will involve:
  - Capital Expenditure
    - Equipment Repair versus Equipment Replacement
    - Equipment or Process Selection
    - New Product or Product Expansion
    - Service or Quality Improvements
  - Cost Reduction



- Time variant
  - Costs, benefits and other parameters are estimated.
  - Values can vary over time:
    - Estimations made today are likely to be different to those made at some time in the future.
- Uncertainty
  - Estimates have to be made relating to future costs and benefits:
    - Based on the best information available at the time.


Time value of money
Differential (incremental) cost and revenue
4 Fundamental Principles of Engineering Economics
Trade-off between risk and reward
Marginal cost and revenue

ENGINEERING ECONOMICS USING EXCEL

FIRST EDITION

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Topics Covered:

- Chapter 1:
  - Overview of MS Excel
- Chapter 2:
  - Interest rates
  - Time value of money
  - Internal rate of return (IRR)
- Chapter 3:
  - Depreciation
  - Sensitivity Analysis
- Appendix 1:
  - Interest rate of an Annuity
  - Interest repayment
  - Principal repayment
  - Number of periods for an investment
- Appendix 2:
  - Reference texts for further reading.

Items introduced in this lecture:

- Chapter 1:
  - Overview of MS Excel
- Chapter 2:
  - Interest rates
  - Time value of money
  - Internal rate of return (IRR)
- Chapter 3:
  - Depreciation
  - Sensitivity Analysis
- Appendix 1:
  - Interest rate of an Annuity
  - Interest repayment
  - Principal repayment
  - Number of periods for an investment
- Appendix 2:
  - Reference texts for further reading.

A brief overview will be provided. Full details are available in the Excel book and the lecture slides.

- Why is Excel so important for Engineering Economics?
  - It facilitates:
    - easier construction of year-by-year cash flow tables
    - easier methods for the application of the time value of money financial equations
    - easier methods for the execution of a sensitivity analysis
    - a more comprehensive analysis of the depreciation of assets and after tax analysis

- Should we forget the basics and focus on Excel?
  - NO
  - Without the basics,
    - The values calculated using Excel will be poorly interpreted
    - Any errors in the Excel calculation will not be noticed or understood
  - WE NEED TO UNDERSTAND THE BASICS AND HOW THEY RELATE TO EXCEL.

- Useful Terms:

i	=	Interest Rate, MARR
N	=	Number of time periods (n = 0, 1, … N)
P	=	Present Value / Present Worth (n=0)
F	=	Future Worth (at some time n)
A	=	Annual Worth / Annual Equivalence
S	=	Savage Value (n = N)

Note:

- P = PV = NPV = PW = NPW
- F = FW
- A = AW = AE (similar to annual cost, AC = EUAC, Equivalent Uniform Annualized Cost)

- Interest rates using Excel:
  - Introduction:
    - Interest rates govern the growth of money with time along with the growth of the economy in general.
    - Albert Einstein once said, “The most powerful force in the universe is **compound interest**.”[1]

1. ”Albert Einstein quotes" ThinkExist.com. Aug 13, 2008 <http://thinkexist.com/quotation/the_most_powerful_force_in_the_universe_is/158830.html>.

- Interest rates using Excel:
  - Key Definitions:
    - Periodic Interest Rate: (i_m)
      - *The interest rate per compounding period is called a periodic interest rate (or periodic rate).*
    - Nominal Interest Rate: (r)
      - *Yearly cost of a loan including interest, insurance, and the origination fee, expressed as a percentage.* (Chan S. Park)
      - *It can also be stated as the periodic rate multiplied by the number of compounding periods.*
    - Effective (Annual) Interest Rate: (i_a)
      - *Rate actually earned or paid in one year, taking into account the affect of compounding.* (Chan S. Park)

- Interest rates using Excel:
  - Periodic Interest Rate:
    - Calculated using basic math functions in Excel:

$$i_m = \frac{r}{M}$$

      - where,

        i_m = periodic interest rate

        r = nominal interest rate

        M = number of compounding periods

- Interest rates using Excel:
  - Nominal Interest Rate:
    - Two possible situations:
      - Case 1:
        - » Calculate the nominal interest rate (r) using the periodic interest rate, i_m
      - Case 2:
        - » Calculate the nominal interest rate (r) using the effective annual interest rate, i_a
          - » Option 1:
            - » Calculate the nominal interest rate (r) using the effective interest rate (i_a) with basic math equations in Excel.
          - » Option 2:
            - » Calculate the nominal interest rate (r) using the effective interest rate (i_a) with a financial function in Excel.

- Interest rates using Excel:
  - Nominal Interest Rate:
    - Case 1:
      - Periodic Interest Rate is known.
      - Calculated using basic math functions in Excel:

$$r = i_m \times M$$

      - where,

        r = nominal interest rate

        i_m = periodic interest rate

        M = number of compounding periods

- Interest rates using Excel:
  - Nominal Interest Rate:
    - Case 2:
      - Effective Interest Rate is known:
      - Option 1:

        Calculated using basic math functions in Excel:

$$r = M\left[\left(i_a + 1\right)^{1/M} - 1\right]$$

      - where,

        r = nominal interest rate

        i_m = periodic interest rate

        M = number of compounding periods

- Interest rates using Excel:
  - Nominal Interest Rate:
    - Case 2:
      - Effective Interest Rate is known:
      - Option 2:

        Calculated using a financial function in Excel:

        $$r = \text{Nominal}(\text{effect\_rate}, \text{npery})$$

      - where,

        effect_rate = effective annual interest rate, i_a

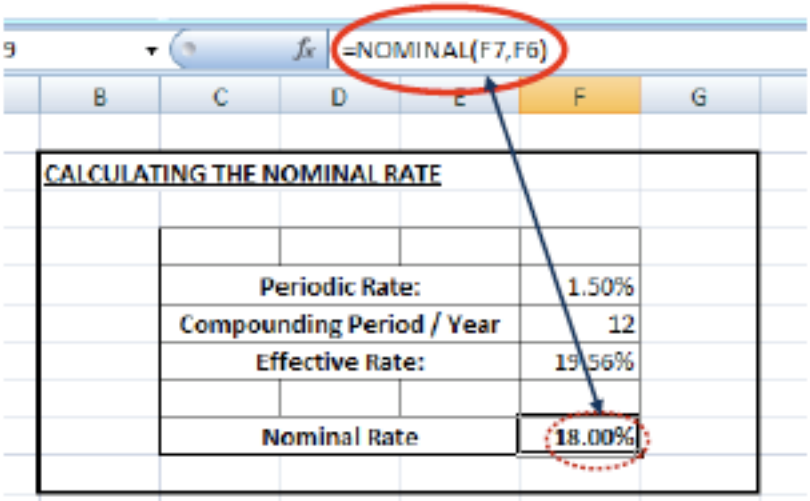
        npery = # compounding periods per year, M

- Interest rates using Excel:
  - Nominal Interest Rate: (Ganguly, example 2.2)

What is the Nominal Annual Interest rate for a financing opportunity that offers an Effective Annual Interest Rate of 19.56%?

Answer:

Exhibit 2.2 Calculating Nominal Rate using Excel



- Interest rates using Excel:
  - Effective Interest Rate:
    - One possible situation:
      - Case 1:
        - » Option 1:
          - » Calculate the effective interest rate (i_a) using the nominal interest rate (r) with basic math equations in Excel.
        - » Option 2:
          - » Calculate the effective interest rate (i_a) using the nominal interest rate (r) with a financial function in Excel.

- Interest rates using Excel:
  - Effective Interest Rate:
    - Case 1:
      - Nominal Interest Rate is known:
      - Option 1:

        Calculated using basic math functions in Excel:

$$i_a = \left(1 + \frac{r}{M}\right)^M - 1$$

      - where,

        r = nominal interest rate

        i_m = periodic interest rate

        M = number of compounding periods

- Interest rates using Excel:
  - Effective Interest Rate:
    - Case 2:
      - Nominal Interest Rate is known:
      - Option 2:

        Calculated using a financial function in Excel:

        $$i_a = \mathrm{EFFECT}(\mathrm{nominal\_rate}, \mathrm{npery})$$

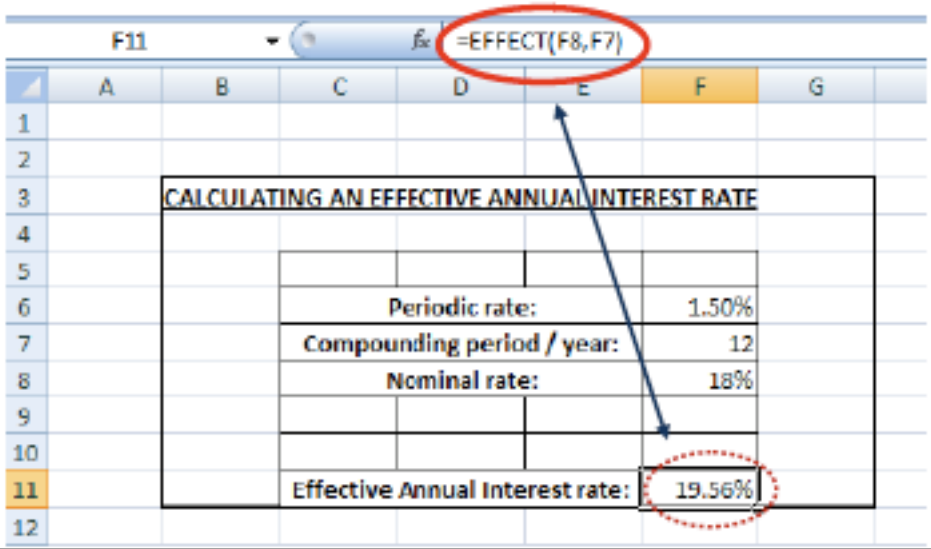
      - where,
        nominal_rate = nominal interest rate, r
        npery = # compounding periods per year, M

- Interest rates using Excel:
  - Effective Interest Rate: (Ganguly, example 2.1)

What is the Effective Annual Interest rate for a financing opportunity that offers an interest of 1.50 % compounded monthly?

Answer:

Exhibit 2.1 Calculating Effective Rate using Excel



- Time value of money and Excel:
  - Key equations summary:

Present Worth

$$PW = -P + A(P/A,i,N) + F(P/F,i,N)$$

$$PW = -P + \sum_{n=0}^{N} A_n(P/F,i,n) + F(P/F,i,N)$$

$$PW = AE(P/A,i,N)$$

$$PW = FW(P/F,i,N)$$

Future Worth

$$FW = -P(F/P,i,N) + A(F/A,i,N) + F$$

$$FW = -P(F/P,i,N) + \sum_{n=0}^{N} A_n(F/P,i,N-n) + F$$

$$FW = AE(F/A,i,N)$$

$$FW = PW(F/P,i,N)$$

Annual Equivalence

$$AE = -P(A/P,i,N) + A + F(A/F,i,N)$$

$$AE = -P(A/P,i,N) + \sum_{n=1}^{N} A_n(P/F,i,N)(A/P,i,N) + F(A/F,i,N)$$

$$AE = -P(A/P,i,N) + \sum_{n=1}^{N} A_n(F/P,i,N-n)(A/F,i,N) + F(A/F,i,N)$$

$$AE = PW(A/P,i,N)$$

$$AE = FW(A/F,i,N)$$

- Time value of money and Excel:
  - Key equations summary:
    - Reminder of Nomenclature:

P = initial investment (n = 0)

A = annual cost / revenue (n = 1, 2, . . . , N)

F = future costs, salvage value or expected income from sale of the item (n = N)

PW = present worth of the investment taking A, F, i and N into account

AE = annual equivalence / worth of the investment taking P, F, i and N into account

FW = future worth of the investment taking P, A, i and N into account

i = interest rate, MARR

N = project life (n=1, 2, . . . , N)

- Time value of money and Excel:
  - Net Present Value: (NPV = NPW = PW = PV)
    - Definition:
      - *NPV compares the value of a dollar today to the value of that same dollar in the future, taking inflation and returns into account.*[1]
      - *The difference between the present value of cash inflows and the present value of cash outflows.*[1]
    - Excel:
      - Two financial functions exist and need to be used in different ways:
        - » NPV function
        - » PV function

1. ”npv” Investopedia ® Investopedia.com. Aug 21, 2008 <http://www.investopedia.com/terms/n/npv.asp>.

- Time value of money and Excel:
  - Net Present Value: (NPV = NPW = PW = PV)
    - Excel:
      - NPV function:

$$NPV = NPV(rate, value1, [value2], ...) - I$$

      - where,

        rate = MARR (minimum attractive rate of return) or the discount factor (interest rate)

        value1, value2, . . . = 1 to 254 arguments representing the payments and income from year 1 to year N.

        I = initial investment = amount invested in year 0
      - The cash flows DO NOT have to be constant for this function to be used.

- Interest rates using Excel:
  - NPV: (Ganguly, example 2.3)

Calculate the Net Present Value of an investment which has an initial investment of \$1,000 with an annual cash inflow of \$100 and a salvage value of \$200. The life of the project is 5 years and the MARR associated with the project is 10%

Answer:

1. Traditional Method

$$PW = -P + A\left(\frac{P}{A}, i, n\right) + S\left(\frac{P}{F}, i, n\right)$$

Hence,

$$PW = -\$1000 + \$100\left(\frac{P}{A}, 10\%, 5\right) + \$200\left(\frac{P}{F}, 10\%, 5\right)$$

Thus,

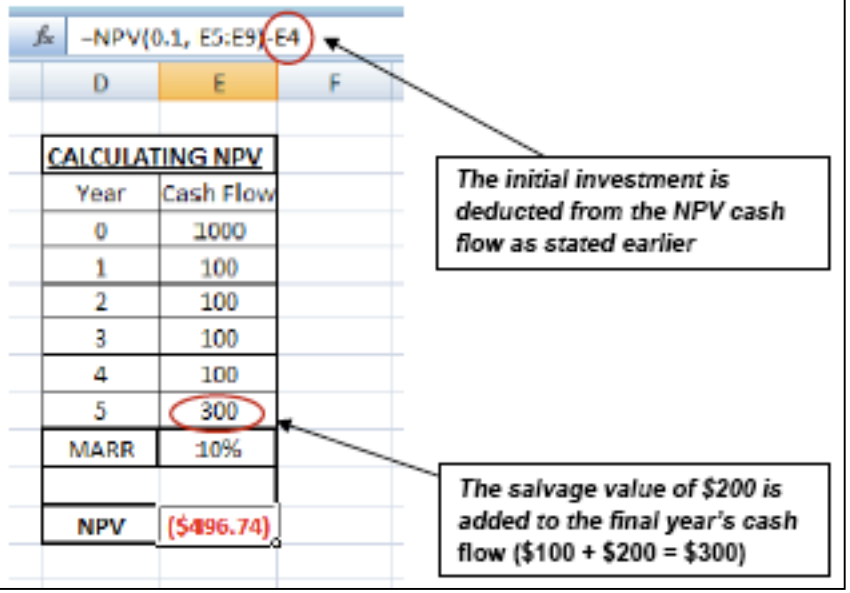
$$PW = -\$1000 + (\$100 * 3.7908) + (\$200 * 0.6209)$$

$$\boldsymbol{PW = (\$\,496.74)}$$

- Interest rates using Excel:
  - NPV: (Ganguly, example 2.3)

2. Spreadsheet Method:

Exhibit 2.4 Calculating NPV using Excel



- Time value of money and Excel:
  - Net Present Value: (NPV = NPW = PW = PV)
    - Excel:
      - PV function:

$$PV = PV(rate, nper, pmt, [fv], type)$$

      - where,

        rate = MARR (minimum attractive rate of return) or the discount factor (interest rate)

        nper = N = project life

        pmt = A = uniform annual cash flow

        fv = F = desired future value once final payment is made

        Type = payment type = 0 (End of year) or 1 (start of year)
      - Function should be used ONLY if there is a uniform cash flow spanning over the given time period.

- Interest rates using Excel:
  - PV: (Ganguly, example 2.3)

Exhibit 2.5 Solving Example 2.3 using the PV() Function

$$Present\ Value = PV(rate, nper, pmt, fv, type)$$

=PV(E10,5,-100,,0)+PV(E10,5,,-200,0)-E4

	D	E	F
	CALCULATING Present Worth Using the PV() Function		
	Year	Cash Flow	Salvage Value
	0	$1,000	-
	1	$100	-
	2	$100	-
	3	$100	-
	4	$100	-
	5	$100	$200
	MARR	10%	-
	PV	($496.74)	

Note that the Cash Flows are inserted as negative and so is the salvage value

Important: Since there is no Future Value, the place is left blank

Important: Since there is no Annual value, the place is left blank

- Time value of money and Excel:
  - Annual Equivalence: (AE = AW)
    - Definition:
      - *The annual equivalent worth measures the worth of an investment by determining equal payments on an annual basis.* (Chan S. Park)
    - Excel:
      - One financial function exists:
        - » PMT function

- Time value of money and Excel:
  - Annual Equivalence: (AE = AW)
    - Excel:
      - PMT function:

$$AE = PMT(rate, nper, pv, [fv], type)$$

      - where,

        rate = MARR (minimum attractive rate of return) or the discount factor (interest rate)

        nper = N = project life

        pv = P = initial investment, I

        fv = F = desired future value of investment

        Type = payment type = 0 (End of year) or 1 (start of year)
      - The existing annuities must also be considered as these are not factored into the pmt function.

- Interest rates using Excel:
  - PMT: (Ganguly, example 2.4)

Calculate the Annual Worth of a financial project that has an initial investment of $1,000 with an annual cash inflow of $300 and a salvage value of $350. The life of the project is 5 years and the MARR associated with the project is 10%

Answer:

1. Traditional Method

$$AW = A - P\left(\frac{A}{P}, i, n\right) + S\left(\frac{A}{F}, i, n\right)$$

Hence,

$$AW = \$300 - \$1000\left(\frac{A}{P}, 10\%, 5\right) + \$350\left(\frac{A}{F}, 10\%, 5\right)$$

Thus,

$$AW = \$300 - (\$1000 * 0.2638) + (\$350 * 0.1638)$$

$$\boldsymbol{AW = \$\,93.53}$$

- Interest rates using Excel:
  - PMT: (Ganguly, example 2.4)

2. Spreadsheet Method

Exhibit 2.6 Determining the Annual Worth using the PMT() function

C14 | =PMT(C12,5,1000,,0)+PMT(C12,5,,-350)+300

	A	B	C	D	E	F	G
1							
2		DETERMINING THE ANNUAL WORTH USING PMT()					
3		Year	Cash Flow	Salvage Value			
4							
5		0	$1,000				
6		1	$300				
7		2	$300				
8		3	$300				
9		4	$300				
10		5	$300	$350			
11							
12		MARR	10%				
13							
14		AW	$93.53				

The Existing Annuities (A) are added back

Note that the Initial Investment is inserted as positive and the salvage value is negative

Important: Since there is no Future Value, the place is left blank

Important: Since there is no Present Value, the place is left blank

- Time value of money and Excel:
  - Net Future Value: (NFV = NFW = FV = FW)
    - Definition:
      - *The value of an asset or cash at a specified date in the future that is equivalent in value to a specified sum today.* (Chan S. Park)
    - Excel:
      - One financial function exists:
        - » FV function

- Time value of money and Excel:
  - Net Future Value: (NFV = NFW = FV = FW)
    - Excel:
      - FV function:

$$FV = FV(rate, nper, pv, pmt, type)$$

      - where,

        rate = MARR (minimum attractive rate of return) or the discount factor (interest rate)

        nper = N = project life

        pv = P = initial investment, I

        pmt = A = uniform annual cash flow

        Type = payment type = 0 (End of year) or 1 (start of year)
      - The salvage value must also be considered as this are not factored into the fv function.

- Interest rates using Excel:
  - FV: (Ganguly, example 2.5)

Calculate the Future Worth of a financial project that has an initial investment of $1,000 with an annual cash inflow of $500 and a salvage value of $700. The life of the project is 5 years and the MARR associated with the project is 10%.

Answer:

1. Traditional Method

$$FW = S + A\left(\frac{F}{A}, i, n\right) - P\left(\frac{F}{P}, i, n\right)$$

Hence,

$$AW = \$700 + \$500\left(\frac{F}{A}, 10\%, 5\right) - \$1000\left(\frac{F}{P}, 10\%, 5\right)$$

Thus,

$$AW = \$700 + (\$500 * 6.0151) - (\$1000 * 1.6105)$$

$$\boldsymbol{AW = \$\,2142.04}$$

- Interest rates using Excel:
  - FV: (Ganguly, example 2.5)

2. Spreadsheet Method

Exhibit 2.7 Determining the Future Worth using the FV() function

C14 =FV(0.1,5,-500,1000,0)+700

	A	B	C	D
1				
2		DETERMINING THE FUTURE WORTH USING FV()		
3		Year	Cash Flow	Salvage Value
4				
5		0	$1,000	
6		1	$500	
7		2	$500	
8		3	$500	
9		4	$500	
10		5	$500	$700
11				
12		MARR	10%	
13				
14		AW	$2,142.04	

The Salvage Value (S) is added back

Note that the Initial Investment is inserted as positive and the salvage value is negative

- Internal Rate of Return (IRR) and Excel:
  - Definition:
    - Internal Rate of Return: (Chan S. Park)
      - *The actual interest rate that the firm earns on its investment.*
      - *The IRR equates the present worth, future worth and annual equivalence worth of the entire series of cash flows to zero.*
  - Methods of Calculation:
    - Direct solution method
    - Trial-and-error method
    - Computer solution method

- Internal Rate of Return and Excel:
  - Computer solution method:
    - Solve graphically
    - Excel financial function:

$$IRR = IRR(values, guess)$$

      - where,

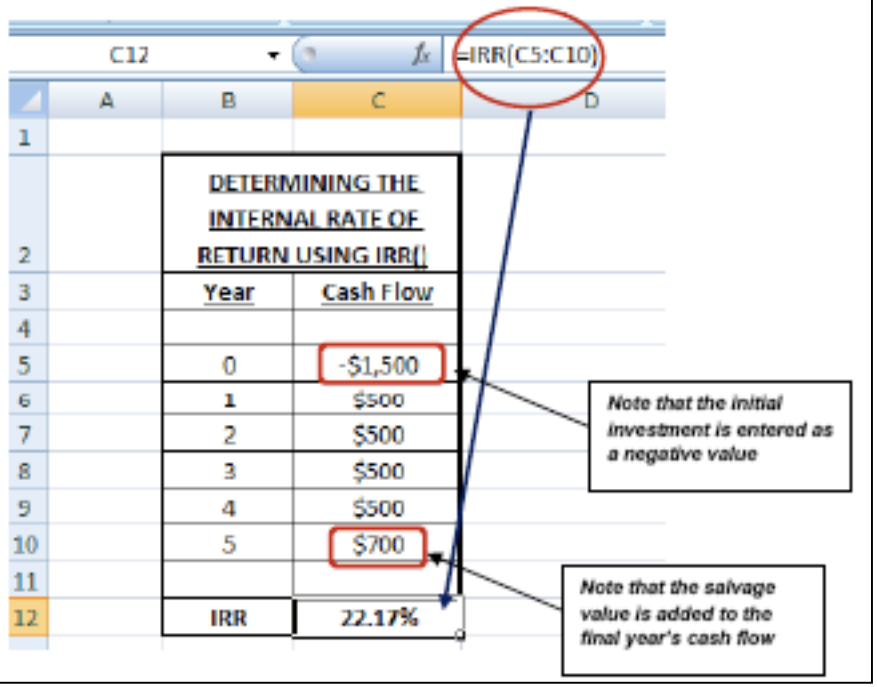
        Values = cash flow (including initial investment and salvage value if any)

        Guess = an IRR value can be estimated. This can be left blank as in this example.

- Interest rates using Excel:
  - IRR: (Ganguly, example 2.6)

Determine the IRR for an economic project that has an initial investment of $1,500 and a periodic cash inflow of $500 for 5 years. The salvage value for the project is $200, which is recovered at the end of the project's life.

Exhibit 2.9 Calculation of Internal Rate of Return using Excel



Questions?