STEVENS
INSTITUTE of TECHNOLOGY
THE INNOVATION UNIVERSITY®

E355 - Engineering Economics

Lecture 01: Introduction to Engineering Economics

Chapter #1

Lecture Contacts

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Welcome to your Course!

Section A:

- Tuesdays & Thursdays 9:30 – 10:45PM

Section B:

- Tuesdays & Thursdays 11:00 – 12:15PM

Section C:

- Tuesdays & Thursdays 12:30 – 1:45PM

Section D:

- Tuesdays & Thursdays 12:30 – 1:45PM

Lab Contacts

XXXXXXX

School of Systems & Enterprises

Lab Instructor

Email: XXXX@stevens.edu

Raif Bucar

Lead Lab TA

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Email: rbucar@stevens.edu

Lab Overview

Online: **LA**

Only One lab section, entirely on-line

- Contact **Lab TA or Lab worker** for lab help/questions, grading questions and all other lab issues.
- **Do not** contact course TA for lab related issues.

Lab Overview

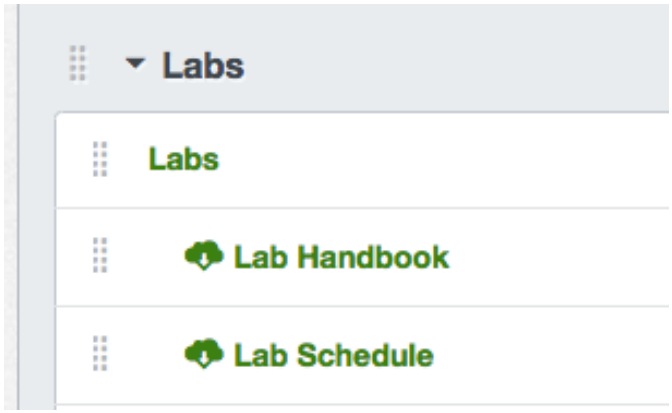
- Online Lab does not have specific meeting times.
- All material needed to complete the labs can be found on Canvas.
- All **lab submission** is done through **Canvas**.
- Due dates for all sections can be found in the **lab schedule**.
- If you have a **lab question or problem**, you must contact your assigned **LAB TA!**
- **Read the Lab Handbook!**

E355 Lab Component

- **Eight labs** during the semester
- All lab materials are in **Labs section on Canvas**
- **Online labs** labs all have the **same requirements**
- See Canvas for MP4 introduction for each lab
- See **Lab Handbook** and Lab Schedule for **Lab Descriptions, Lab Due Dates, Lab Policies**
- Labs are worth **16% of your E355 Grade**
- YOU are responsible for ensuring that labs are submitted properly. DOUBLE CHECK! If your lab is not there, or the wrong file, you will get a **zero**.
- **Late labs: 50% off first 24 hours, zero grade after that**

Example Lab Info on Canvas

General Lab Info



Typical Lab

E 355 Lab Schedule - Fall 2016

Lab lectures are on Thursdays from 2:00pm to 3:50pm

Labs are due on Tuesdays at 11:30pm

	Monday	Tuesday	Wednesday	Thursday	Friday
August	29	30	31	1	2
September	5 No Classes	6	7	8	9
	12	13	14	15	16
	19	20	21	22	23
	26	27	28	29	30
October	3	4	5	6	7
	10 No Classes	11	12	13	14
	17	18	19	20	21
	24	25	26	27	28
November	31	1	2	3	4
	7	8	9	10	11
	14	15	16	17	18
	21	22	23 No Classes	24 No Classes	25 No Classes
	28	29	30	1	2
December	5	6	7	8	9

Course Overview

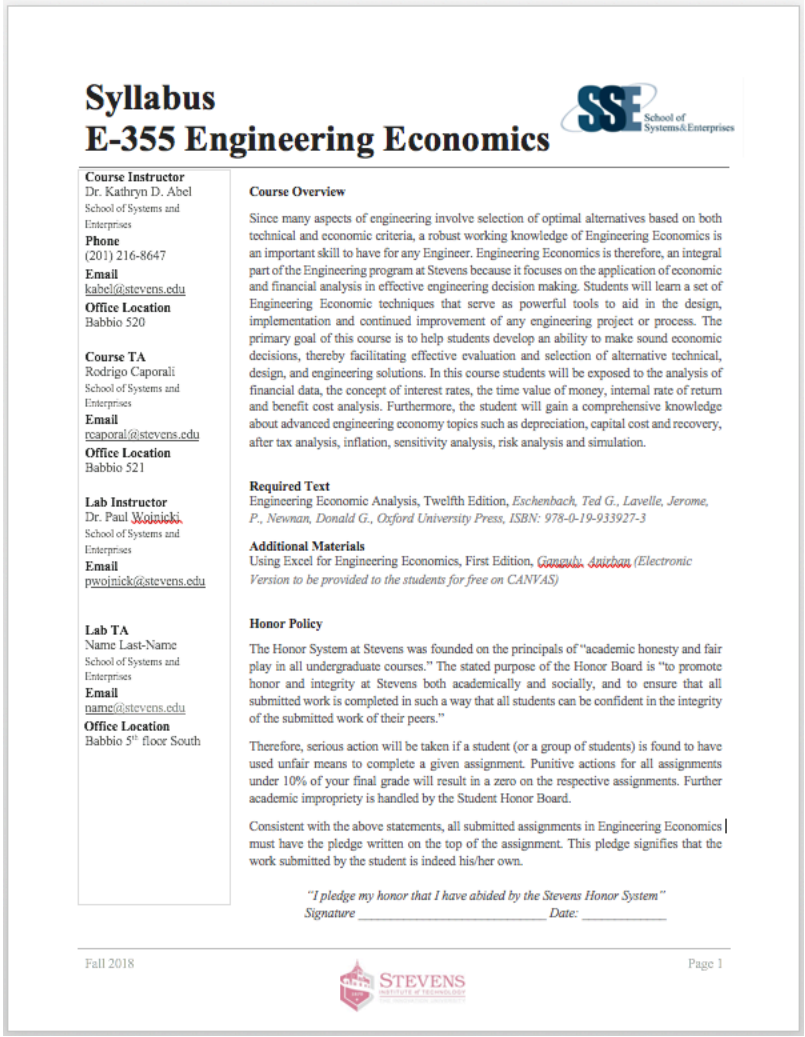
Lecture Objectives

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

Items to review

- Recommended textbook
- Schedule
- Class deliverables
  - Classwork assignments
  - Homework assignments
  - Quizzes
  - Labs
  - Extra Credit
- Grading Scheme
  - Point distribution
  - Submission policy



Syllabus
E-355 Engineering Economics

School of Systems & Enterprises

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Course Overview

Since many aspects of engineering involve selection of optimal alternatives based on both technical and economic criteria, a robust working knowledge of Engineering Economics is an important skill to have for any Engineer. Engineering Economics is therefore, an integral part of the Engineering program at Stevens because it focuses on the application of economic and financial analysis in effective engineering decision making. Students will learn a set of Engineering Economic techniques that serve as powerful tools to aid in the design, implementation and continued improvement of any engineering project or process. The primary goal of this course is to help students develop an ability to make sound economic decisions, thereby facilitating effective evaluation and selection of alternative technical, design, and engineering solutions. In this course students will be exposed to the analysis of financial data, the concept of interest rates, the time value of money, internal rate of return and benefit cost analysis. Furthermore, the student will gain a comprehensive knowledge about advanced engineering economy topics such as depreciation, capital cost and recovery, after tax analysis, inflation, sensitivity analysis, risk analysis and simulation.

Required Text
Engineering Economic Analysis, Twelfth Edition, *Eschenbach, Ted G., Lavelle, Jerome, P., Newnan, Donald G., Oxford University Press, ISBN: 978-0-19-933927-3*

Additional Materials
Using Excel for Engineering Economics, First Edition, *Ganguly, Anirban (Electronic Version to be provided to the students for free on CANVAS)*

Honor Policy

The Honor System at Stevens was founded on the principals of "academic honesty and fair play in all undergraduate courses." The stated purpose of the Honor Board is "to promote honor and integrity at Stevens both academically and socially, and to ensure that all submitted work is completed in such a way that all students can be confident in the integrity of the submitted work of their peers."

Therefore, serious action will be taken if a student (or a group of students) is found to have used unfair means to complete a given assignment. Punitive actions for all assignments under 10% of your final grade will result in a zero on the respective assignments. Further academic impropriety is handled by the Student Honor Board.

Consistent with the above statements, all submitted assignments in Engineering Economics must have the pledge written on the top of the assignment. This pledge signifies that the work submitted by the student is indeed his/her own.

"I pledge my honor that I have abided by the Stevens Honor System"
Signature _____ *Date:* _____

Fall 2018 STEVENS Page 1

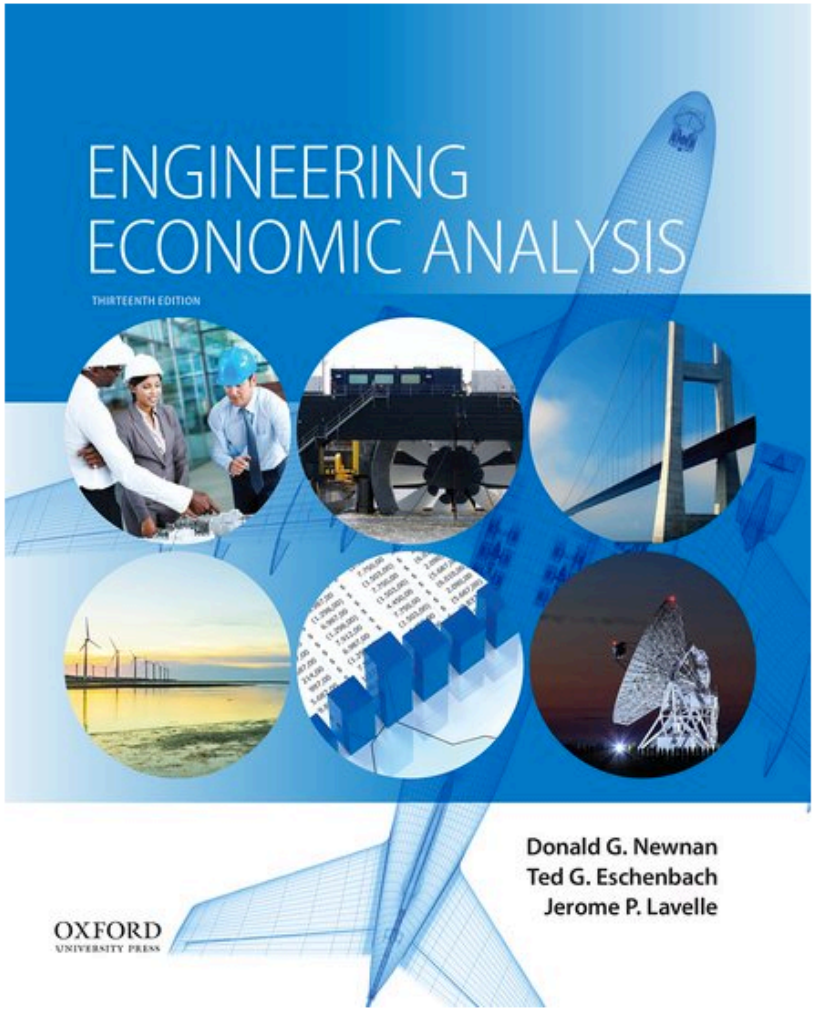
Course Overview

Recommended textbook

Primary text:

Eschenbach, Ted G., Lavelle, Jerome, P., Newnan, Donald G., *Engineering Economic Analysis*, Thirteenth Edition, Oxford University Press

ISBN: 978-0-19-977804-1



Course Overview

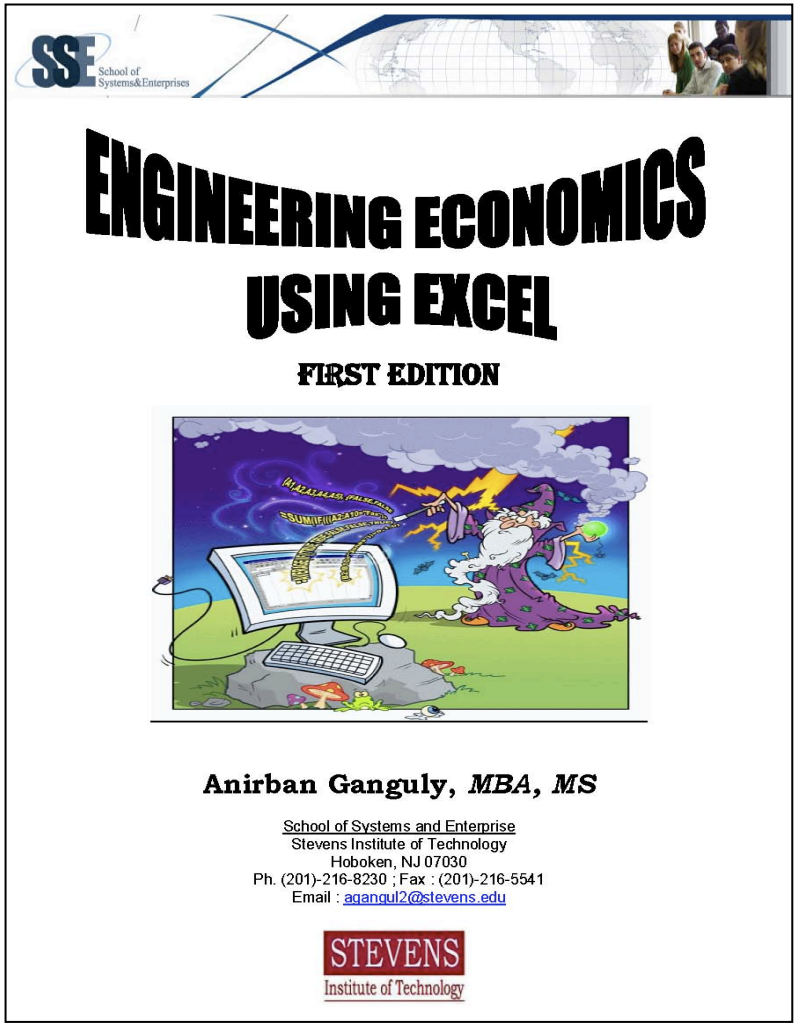
Recommended textbook

Supporting text:

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

  **Electronic version to be provided to the students via Canvas

- Lang, Hans J. and Merino, Donald M. The Selection Process for Capital Projects. New York: John Wiley & Sons, Inc. 2002.



Course Overview

Lecture 1: Introduction to Engineering Economics

Chapter 1

- 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.
- Ethics

Course Overview

Lecture 2: Understanding Cash Flow Diagrams, Interest Rates and Time Value of Money

Chapters 2, 3, 4

- 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

Course Overview

Lecture 3: Understanding the 3 Worth's, Capitalized Cost & Capitalized Recovery

Chapters 5,6,9

- Three Worth's: Present Worth, PW; Annual Equivalence, AE; Future Worth, FW
- Evaluation of Alternatives based on time value of money
- Capitalized Costs
- Capitalized Recovery

Course Overview

Lecture 4: Understanding Rates of Return, Ranking for Technological Exclusivity

Chapters 7, 8

- Return on Investment (ROI)
- IRR: Internal Rate of Return
- Incremental IRR
- Mutually Exclusive Alternatives

Course Overview

EXAMS – In the past

- **Total of 3 Exams**
- **ALL EXAMS ARE CLOSED BOOK**
- Students will be provided with Formula Sheet(s)
- Must bring own calculator
- Tables will be provided
- Absolutely NO cell phone or laptop use during the exams
- **Students MUST take their exams in their enrolled section or risk loss of points!**

Course Overview

EXAMS – While we are all virtual

- **Total of 3 quizzes**
- **ALL QUIZZES ARE OPEN BOOK**
- Students may use Formula Sheet(s)
- Must bring own calculator
- Students must provide their own Tables
- Absolutely NO cell phone use during the exams
- **Students MUST take their exams in their enrolled section or risk loss of points!**

Course Overview

Lecture 5 A: Benefit-Cost Analysis, Sensitivity and Breakeven Analysis, Depreciation

Chapter 9

- Valuation of Benefits and Costs
- Definition of Benefit-Cost Ratio (BCR)
- Calculation of BCR (including Incremental BCR)
- Overview of Depreciation
- Depreciable versus Non-Depreciable Assets
- Types of Depreciation
- Overview of break-even analysis
- Overview of sensitivity analysis
- Calculations and graphs used in sensitivity analysis
- Evaluating mutually exclusive alternatives using sensitivity analysis

Course Overview

Lecture 5 B: Benefit-Cost Analysis, Sensitivity and Breakeven Analysis, Depreciation

Chapter 11

- Valuation of Benefits and Costs
- Definition of Benefit-Cost Ratio (BCR)
- Calculation of BCR (including Incremental BCR)
- Overview of Depreciation
- Depreciable versus Non-Depreciable Assets
- Types of Depreciation
- Overview of break-even analysis
- Overview of sensitivity analysis
- Calculations and graphs used in sensitivity analysis
- Evaluating mutually exclusive alternatives using sensitivity analysis

Course Overview

Lecture 6: After Tax Analysis

Chapter 12

Excel Examples

- Corporate taxes
- Treatment of capital gains and losses
- Treatment of non-cash expenses
- After tax cash flow
  - Developing cash flow statements
  - Developing cash flow equations
- Application of Excel to after tax analysis

Course Overview

Lecture 7: Retirements & Replacements

Chapter 13

- Basic Concepts and terminologies
- Economic Life
- Replacement Analysis under different conditions
- Replacement Analysis with after tax consideration

Course Overview

Lecture 8: Inflation

Chapter 14

- Introduction to Inflation
- Measuring / assessing inflation
- Equivalence calculation under inflation (real, constant, and actual dollars)
- Impact of inflation on capital projects

Course Overview

Lecture 9: Cost Concepts & Capital Budgeting; Decision & Risk Analysis (Intro to Probability & Statistics in Engineering Economics)

Chapters 10, 15

- General cost concepts including the classification of costs / types of costs
- Introduction to capital budgeting
- Cost of capital
- Choice of MARR
- Capital budgeting decisions
- 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

Course Overview

Green Economics

- Definition of Green Economics
- Examples of Green Economics
- Value of After Tax Analysis
- Case Studies – to be discussed in class

Course Overview

Grading Scheme

Point distribution (No Final)

Item	Quantity	Percentage	Total Points
Classwork Assignments (group)	8	16%	48
Homework Assignments (group)	8	33.3%	100
Quizzes (individual)	3	33%	99
Labs (individual)	8	16.6%	250/5
Extra Credit (all)	0	1%	3

Please refer to the Grade Grid for full details.

Students MUST take their exams in their enrolled section or risk loss of points!

How to Submit Work Electronically

1 – Scan/Save your work.

Check the file. You are responsible for your submission. Your work must be complete and legible or points could be lost.

2 - Save as ONLY ONE PDF file.

Only the last file submitted will be graded, so it is ok to submit multiple times if you want to update something after you submitted.

3 - Name your file using the following standards (as example) HW#_YourSectionLetter.pdf.

Do not include your name on the file. Please use capital letters like the examples below:

Examples: HW1_A.pdf, HW2_B, HW3_C.

Note that this naming convention is very important for grading purposes since it helps the TAs to manage a large number of submissions.

4 - Upload the file and submit it.

Re: Electronically Submitted Work

- Students may resubmit documents as many times as they like
- Only the last document submitted will be the document that is graded
- No need to leave comments on changing submittal documents prior to deadline
- No need to leave comments with the pledge
- Leave a comment only if the last submittal document needs a clarification

KEY POINTS of Submission Policy

- All **WORK** is due by the date and the time provided in the schedule.
- All **WORK** MUST be submitted as a **scan** and submitted electronically through Canvas as a SINGLE PDF file!
- **LABS** are due via Canvas As Per Lab Schedule
- **Late Assignments: 50% off first 24 hours, zero grade after that**

Summary of KEY POINTS to be noted

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.

- **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.

Course Objectives

Course Objectives

- **Expose** students to:
  - the analysis of **financial data**
  - the concept of **interest rates**
  - time value of money
- Provide students with a set of basic **tools and techniques** to **analyze** and make **choices** between alternative **engineering projects**. Tools will include:
  - the time value of money
  - the internal rate of return
  - the benefit cost ratio

Course Objectives

- Allow students to comprehend **advanced** engineering economics **topics** like:
  - depreciation of assets
  - after tax cash flows
  - inflation
- Acquaint students with **decision making tools** like:
  - sensitivity analysis
  - risk analysis
  - simulation

What is Engineering Economics?

What is Engineering Economics?

- Engineering is the discipline, skill, and profession of acquiring and applying scientific, economic, social, and practical knowledge, in order to design and build structures, machines, devices, systems, and material processes.[2]
- 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]

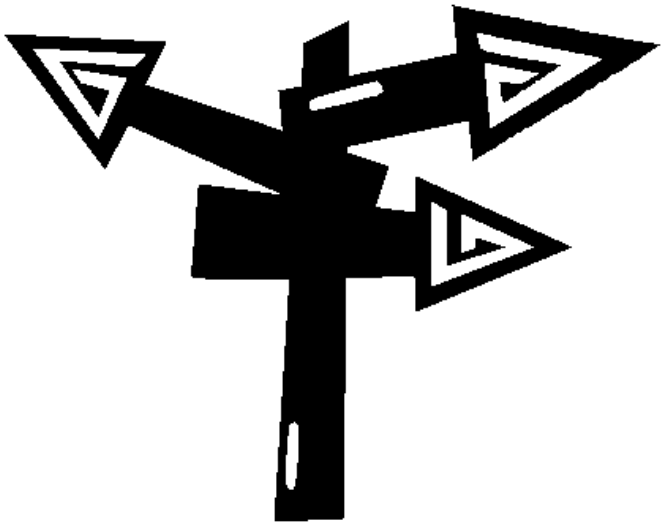
1. ASTM Dictionary of Engineering Science and Technology (10th Edition). (pp. 214). ASTM International. Online version available at: http://www.knovel.com/knovel2/Toc.jsp?BookID=1741&VerticalID=0

2. en.wikipedia.org/wiki/Engineering economics

What is Engineering Economics?

Key concepts:

- Estimating using economic techniques
- Evaluating / choosing between alternatives

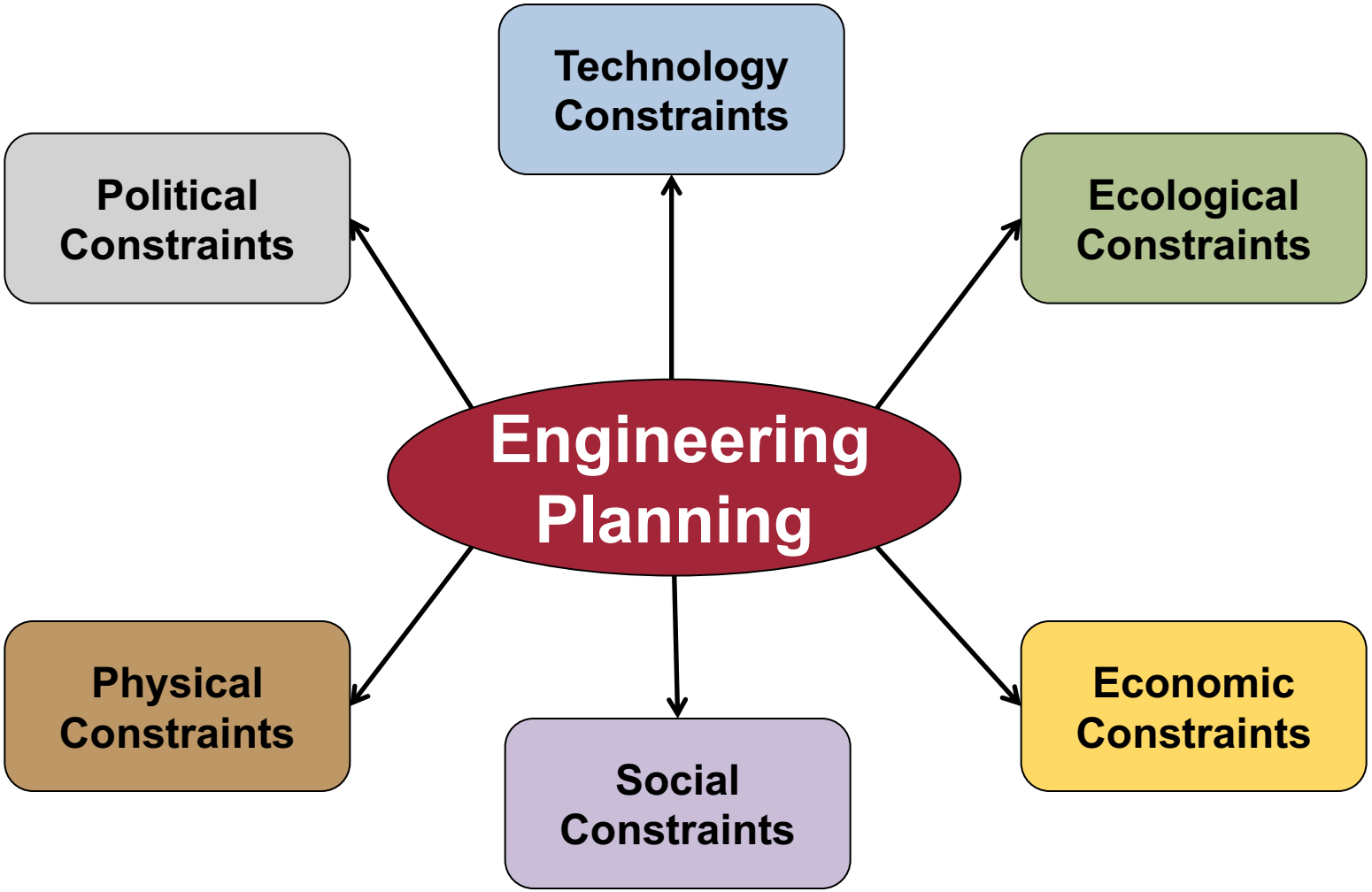


Stevens Legacy

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.

What is Engineering Economics?



Why study Engineering Economics?

Capital Selection Process

- Rationale selection process needed to **allocate capital efficiently**.
- The **Strategic Plan** of an entity that contains capital expenditures usually drives this process.
- Capital selection is a **disciplined decision making process**
- Over the **long run** – a disciplined process will produce superior results

Why study Engineering Economics?

Engineering Economics is **NOT** the only tool that should be used when evaluating a capital investment.

- Risk
- Reward
- Time
- Resources available

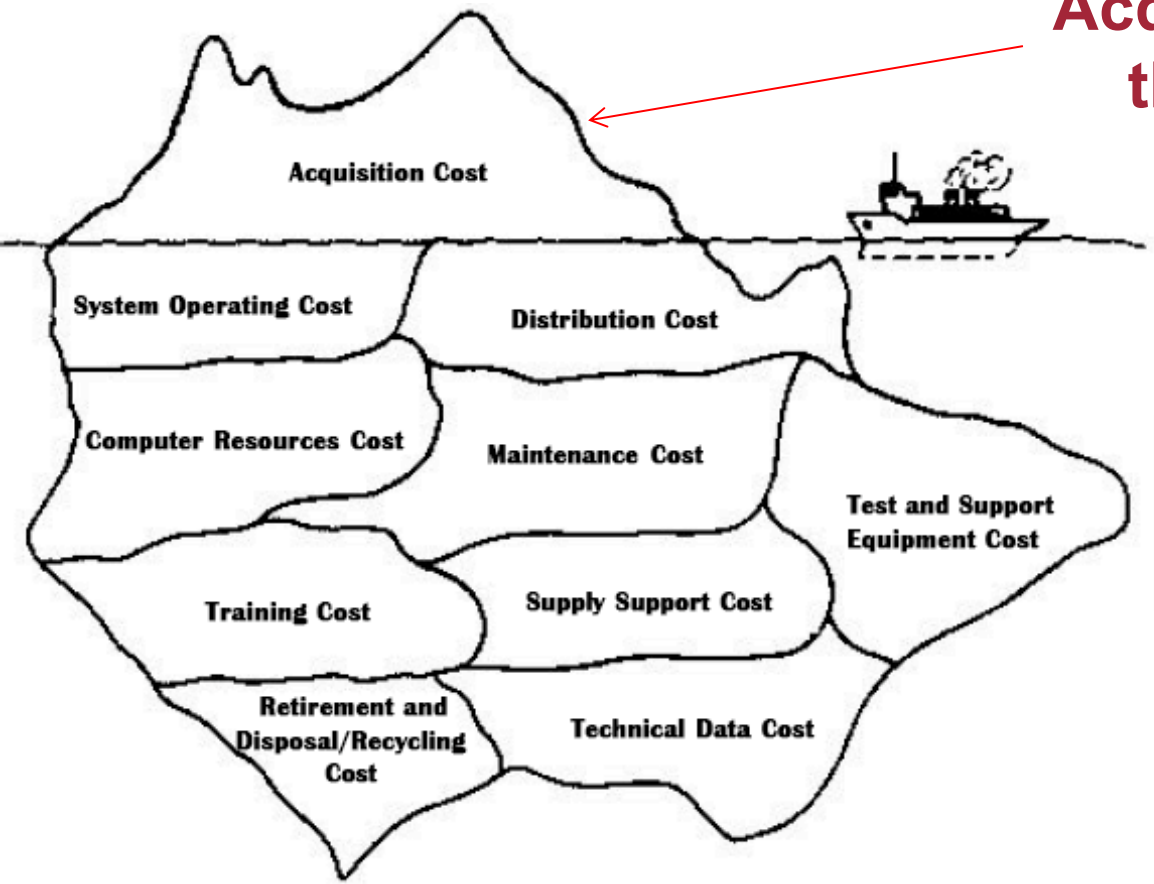
Why study Engineering Economics?

Helps with real life personal decisions.

Projects require economic analysis to support engineering decisions.

Why study Engineering Economics?

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

Decisions in Engineering Economics

Decisions in Engineering Economics

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

Decisions in Engineering Economics

Efficient **allocation of resources** answer the three economic questions:

1. **What to produce?**

Some resources are rare and need to be distributed properly

Ex. Hospitals vs. Weapons

2. **How to produce?**

Paying for workers, tools, land, etc.

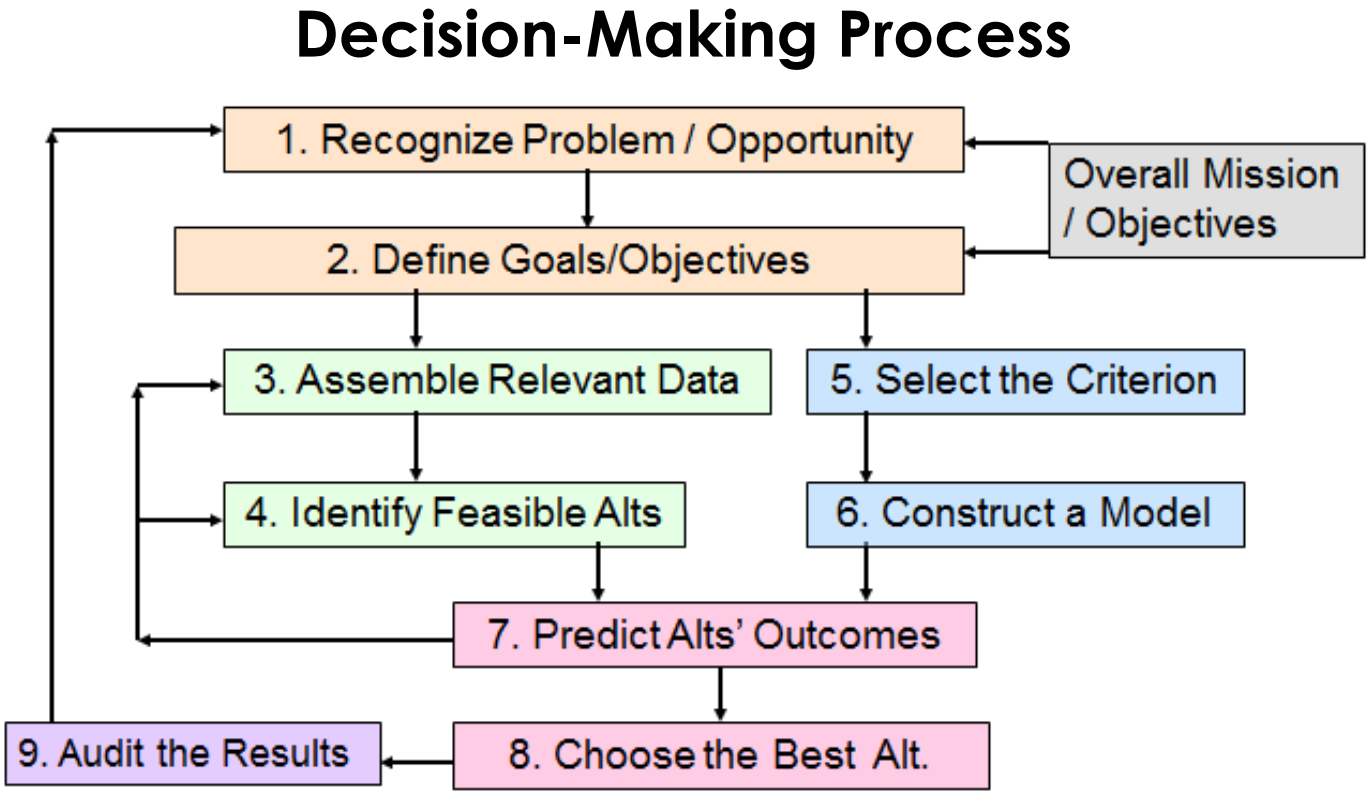
3. **For whom to produce?**

Because of scarcity, not everyone can be satisfied

Know the right questions to ask!

Decision Making Process

This course develops the tools to properly analyze and solve the economic problems that are commonly faced by engineers.



Limitations of Engineering Economics

Limitations of Engineering Economics

Time variant

- Costs, benefits and other para-meters 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.

Fundamentals of Engineering Economics

Fundamental Principles of Engineering Economics

- Time value of money
- Differential (incremental) cost & revenue
- Trade-off between risk & reward
- Marginal cost & revenue

Ethics in Engineering Economics

Ethics in Engineering Economics

The concept of distinguishing between **right** and **wrong** in decision making.

Ethics includes:

- Establishing systems of **beliefs** and **moral obligations**
- Defining **values** and **fairness**
- Determining **duty** and **guidelines** for conduct

Code of Ethics

National Society of Professional Engineers

Fundamental Canons

Engineers, in the fulfillment of their professional duties, shall:

1. Hold paramount the safety, health, and welfare of the public.
2. Perform services only in areas of their competence.
3. Issue public statements only in an objective and truthful manner.
4. Act for each employer or client as faithful agents or trustees.
5. Avoid deceptive acts.
6. Conduct themselves honorably, responsibly, ethically, and lawfully so as to enhance the honor, reputation, and usefulness of the profession. (https://www.nspe.org/)

Ethics in Engineering Economic Analysis

How well and how **honestly** the decision-making process is conducted – the data, method of analysis, recommendations, and follow up.

Recognize ethical issues exist and make them an **explicit part** of **decision making process.**

Importance of Engineering Economics

Why is this class important?

Engineering economics is necessary for an engineer to effectively:

- **Select capital projects**
  *Which engineering projects are **worthwhile**?*
  *Which engineering projects should have a higher **priority**?*
- **Allocate resources**
  *How should the engineering project be **designed**?*
- **Compare different ways to finance purchases**
  *What is the **best way to finance** my new car?*
- **Make short- and long-term investment decisions**
  Is a higher salary better than receiving stock options?
- **Achieve long-term financial goals**
  Both professionally and personally

STEVENS
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Accelerated Masters Program (AMP)

Should you do it?
How do you do it?
How much money will it save?

Kathryn D. Abel, Ph.D.
School of Systems & Enterprises

School of Systems and Enterprises (SSE)

- SSE Master degrees combine very well with many different undergraduate engineering degrees
- Engineering Management
- Socio-Technical Systems Engineering
- Software Engineering
- Space Systems Engineering
- Systems Analytics
- Systems Engineering

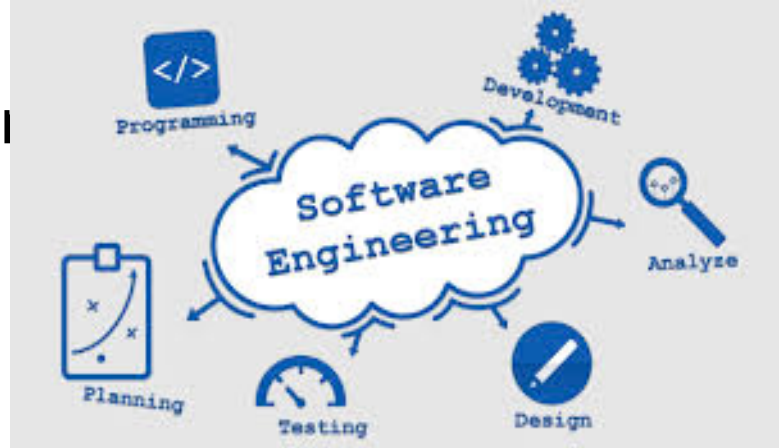
SSE Master Degrees

- **Engineering Management** provides skills in the creation, application and management of technology to solve complex problems, invent new processes and products and build new enterprises.

- **Socio-technical Systems Engineering** provides students with the ability to analyze and model complex large-scale technology-intensive systems (transportation systems, power girds, etc), design policies and strategies for their sustainable management and propose ways for their continuous improvement.

SSE Master Degrees

- **Software Engineering** provides skill sets to design, build, test, and maintain software systems, and manage software projects with optii efficiency.

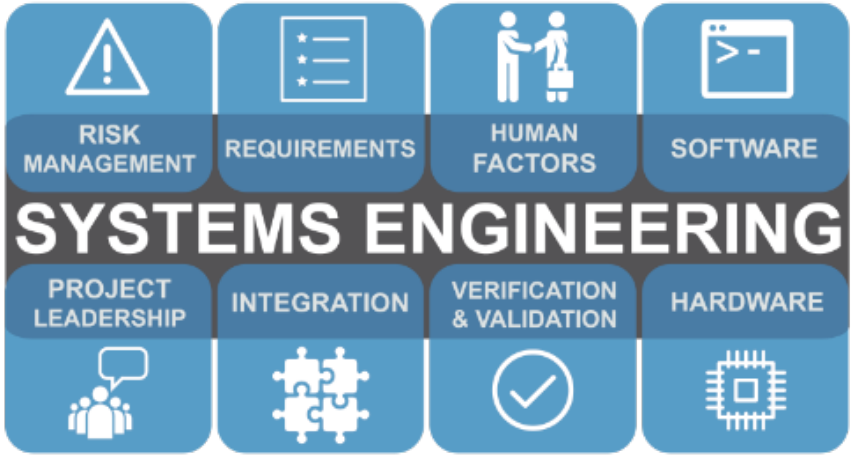


- **Space Systems Engineering** combines robust technical education in space systems design and development, and key space systems processes, with a holistic understanding of systems engineering principles.

SSE Master Degrees

- **Systems Analytics** provides data-driven insights and data analytics and visualizations to facilitate and optimize intelligent decision-making across industries today.

- **Systems Engineering** provides multidisciplinary skills and approaches needed to architect, design and manage complex technical systems and processes throughout their life cycles.



Normally…..

- Bachelor = 8 semesters
  - ($26k each)
- Master (10 classes) = 3 semesters
  - ($18k each)
  - Rule = enrollment in no more than 4 grad classes per term
- Total = 8 + 3 = 11 semesters

4 + 1…..

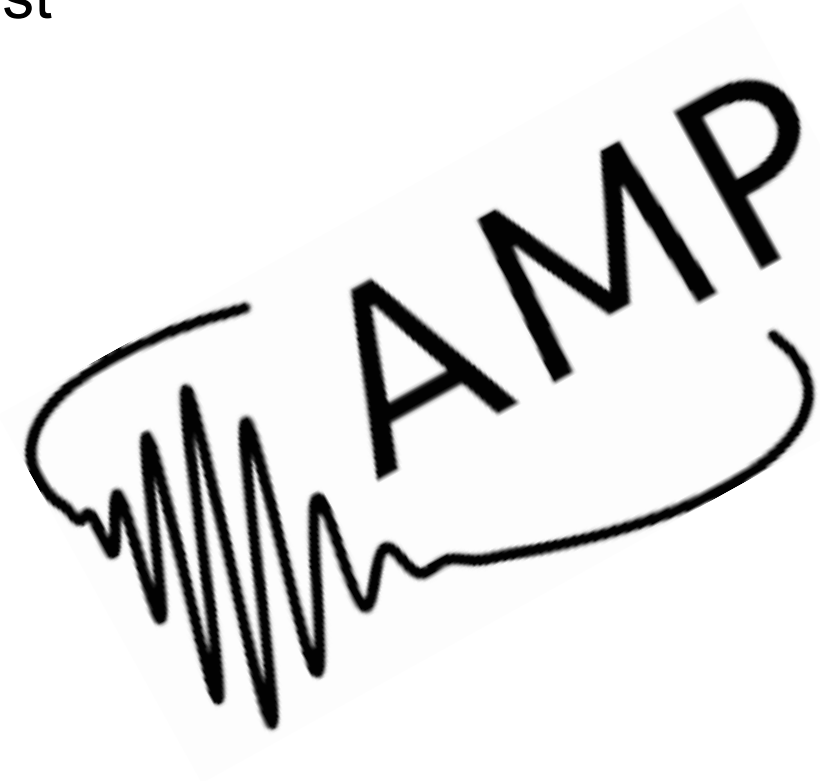
- 4+1 provides 20% discount for a 10 course master
- This equates to a savings of $11k
- However, must take 3 more classes than if on AMP
- 4+1 can switch over to AMP

Benefits of AMP

- Complete bachelors and masters in 8 + 1 = 9 semesters (instead of 11)
- Thus save between $8k and $26k overall
- Take 3 less courses to complete both degrees
- No application fee, nor standardized tests required

Requirements to be part of AMP

- Must have >3.0 Cum GPA
- Must have <6 UG credits in the last UG semester
- Must apply during the 6th or 7th semesters via the intranet page
- One semester as a full time graduate student (the rest can be part time and/or online)
- Up to 3 courses can be double counted for both grad & UG
  - Use your general elective slots
  - Use them wisely and get Grad Certs too



Normally or with 4+1

	Spring	Fall	Spring	Fall	Spring	Sum/Fall
	Term 6	Term 7	Term 8			
Category	UG-Junior	UG-Senior	UG-Senior	Grad	Grad	Grad
# UG credits	~20	~20	~20			
Tuition	$26k	$26k	$26k	$18k	$18k	$18k
Grad Courses				4	4	2

If you are ahead with Undergrad Courses

- AMP allows one to….

	Spring	Fall	Spring	Fall
	Term 6	Term 7	Term 8	
Category	Undergraduate	Undergraduate	Graduate	Graduate
# UG credits	~20	~20	< 6 UG	
Tuition	$26k	$26k	$18k	$18k
Grad Courses	1 or 2	2 or 1	3	4

- Saving two semesters of time and money
- Savings equates to $20k to $36k

If you are on schedule with UG Courses

	Spring	Fall	Spring	Fall	Spring
	Term 6	Term 7	Term 8		
Category	UG -Junior	UG -Senior	UG -Senior	Grad	Grad
# UG credits	~20	~20	~20	< 6 UG	
Tuition	$26k	$26k	$26k	$18	$18k
Grad Courses	1	1	1	3	4

- Take three less classes
- (i.e. If you graduate without choosing AMP first you will have to take 10 grad courses for a master)
- Savings equates to $18k

Summary

- If you are ahead in your academics, finish both degrees faster
- If you are on schedule with your UG degree, get a master for 3 less classes
- Each student will have different circumstances
  - financial aid
  - # Grad courses already taken
  - 4+1

with AMP

to get your starting salary to


That's all Folks!

Questions?