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Undergraduate Course on

Introduction to Economic Decision Making for Engineers

0340045

Syllabus. The economic analysis of engineering decisions is based on fundamental economic concepts of discounting, interest, time, inflation, price, value, and more. We study the intuitive meaning of these concepts and their quantitative representation. We examine economic decisions in an engineering context, and put special emphasis on the uncertainties surrounding these decisions in practice. We study info-gap analysis of these decisions based on the concept of robustness to uncertainty, as well as classical probabilistic tools for risk evaluation.

Audience. Engineers interested in practical aspects of economic analysis and decision making with deep uncertainty as they relate to engineering analysis and design.

Prerequisites:

- Linear systems (034032)
- Introduction to probability and statistics (094480)

Weekly hours. 2 hours of lecture, and 1 hour of interactive discussion of homework.

Time and place of lectures and exercise sessions: Tuesdays, 14:30–17:20. Location: Lady Davis room 433.

Office hours: By appointment. Email: yakov@technion.ac.il

Website: http://yakovbh.net.technion.ac.il/courses/introduction-to-economic-decision-making-for-engineers

Miluimnikim (students in military service):

1. Assistance in mastering background material or material of the course is available in coordination with the lecturer.
2. Alternative dates for mid-term and final exams are available in coordination with the lecturer, who will request documentation verifying dates of service.
3. Recordings of the lectures will be made available to those not able to attend in person due to miluim. Attendance in person is recommended, for those who are able, because this allows discussion as well as questions and answers in real time. In addition, exercise sessions are not recorded; they are an important interactive forum for mastering the material. Recordings are available on this webpage:

   https://panoptotech.cloud.panopto.eu/Panopto/Pages/Sessions/List.aspx#folderID=%22dc9d8a8f-fdce-4100-a6e1-b24e00ab3d32%22

   Note: The '-' between "...8a8f" and "fdce..." is a real part of the link; it is not a line-split.

Grading. Course grade based upon:

[0] \lectures\Econ-Dec-Mak\syllabus13edm.tex 30.3.2025

1. **Homework.** Highly recommended. Homework problems will be put on the course website each week. The exercise session will be done in "reverse" mode: students will work individually or in small groups, guided by the instructor, rather than frontal presentation of the solutions. Solutions will be posted on the website afterwards. Solving homework problems each week will enable mastery of the material.
2. **Mid-term exam.** Optional. One optional mid-term exam will be given. It will be 1 hour duration and will have a weight of 40% in the final grade. The weight of the mid-term is moved to the final exam if the mid-term grade does not improve the final grade. Each student is allowed one 2-sided page of notes and a hand calculator. Date: to be determined.
3. **Final Exam.** Required, 60% (plus weight of the mid-term exam as necessary). A grade of less than 50 on the final exam will be recorded as the final grade in the course. Each student is allowed two 2-sided pages of notes and a hand calculator. Moed Alef: 17.7.2025. Moed Bet: to be determined. If a student takes the exam more than once, it is the last grade that is recorded.

Learning Outcomes

- Master the concept and calculation of compound interest.
- Use compound interest to prioritize alternative projects.
- Evaluate present worth of investments and loans. Incorporate probabilistic and info-gap uncertainty in costs, returns and interest.
- Master the concept and calculation of benefit-cost ratio. Incorporate probabilistic and info-gap uncertainties.
- Master the concept and calculation of present worth with inflation and foreign exchange.

Outline of Lectures

Basic Concepts and Applications

Lecture 1. **Discounting, interest, and time: fundamentals.**[1] Basic economic concept and intuition of the time-value of money. Examples and quantitative models.

Lecture 2. **Discounting, interest, and time: Applications.**[2] Applications and quantitative models of the basic economic concept and intuition of the time-value of money.

Lectures 3–6. **Decision analysis and implications of uncertainty.**[3] Info-gap robustness analysis and probabilistic analysis of uncertainty in interest rate and rate of return. Strategic uncertainty. Opportuneness.

Lectures 7–9. **Benefit-Cost Ratio.**[4] Benefits are sometimes non-monetary, while costs usually are monetary. When benefits and costs are not commensurable, the difference between them is not a useful decision guide. However, the ratio of benefit to cost is still meaningful. We explore the benefit-cost ratio and consider the implications of uncertainty. Info-gap robustness analysis.

Lectures 10–12. **Price changes: Inflation and foreign exchange.**[5] Basic economic concepts of inflation, sector-specific inflation, real and nominal interest, and foreign exchange rates. Examples

[1] Lecture notes on Time-Value of Money, part I. \lectures\Intro-Econ-DM\money-time02.pdf.
[2] Lecture notes on Time-Value of Money, part II. \lectures\Intro-Econ-DM\money-time02.pdf.
[3] ○ Lecture notes on Time-Value of Money, part III. \lectures\Intro-Econ-DM\money-time02.pdf.
○ Yakov Ben-Haim, *Info-Gap Economics* (*IGE*), sections 1.2–1.3, 2.1–2.2.
[4] Lecture notes on The Benefit-Cost Ratio. \lectures\Intro-Econ-DM\benefit-cost02.pdf.
[5] Lecture notes on Price Changes: Inflation and Foreign Exchange. \lectures\Intro-Econ-DM\price-change02.pdf.

and quantitative models. Application in engineering design. Info-gap robustness analysis of economic decisions involving inflation and price changes.

Lecture 13. **Forecasting.**[6] Forecasting of economic conditions is a central tool in planning. We explore info-gap methods for forecasts based on dynamic models, and for prediction based on empirical regression.

Special Topics

(Included as time permits)

Special topic 1. **Portfolio investment with uncertain returns.**[7] Allocation of a limited budget among assets with uncertain returns is studied first from the perspective of mean-variance optimization and then extended by using info-gap robustness against uncertainty.

Special topic 2. **Project valuation.**[8] Value at risk (VaR) methods are a standard tool for investment valuation. However, for highly novel projects we often are uncertain about the probability distribution of the project value. We use info-gap theory to study VaR methods with uncertain pdf's.

Special topic 3. **Project scheduling.**[9] Projects are often one-of-a-kind, entailing tasks that have not been performed before, especially in the innovative and hi-tech sectors. Project durations are therefore highly uncertain. We explore task-scheduling and related planning considerations and their economic implications.

Special topic 4. **Behavioral response to feedback.**[10] The Israel Electric Corporation reports to consumers their level of energy consumption compared to a local mean. The goal is to encourage energy conservation, but the outcome may be different. We examine this generically.

Special topic 5. **Strategic asset allocation.**[11] Budget is allocated over time among innovative or emerging ventures to achieve high probability that the future balance is acceptable. However, the probability distribution is uncertain.

Special topic 6. **Lifecycle costs and externalities.** What are externalities? Who pays them? Who should pay them? How do they impact engineering design decisions?

Special topic 7. **Decision analysis and implications of uncertainty.** Info-gap robustness analysis of uncertainty in lifecycle costs and externalities.

Books

Main texts:

1. DeGarmo, E. Paul, William G.Sullivan, James A. Bontadelli and Elin M. Wicks, 1997, *Engineering Economy,* 10th ed., Prentice-Hall.

[6] ○ Lecture Notes on Forecasting, \lectures\Econ-Dec-Mak\forecasting001.tex.
○ Yakov Ben-Haim, *Info-Gap Economics,* chapter 6: Estimation and Forecasting.
○ Yakov Ben-Haim, 2009, Info-gap forecasting and the advantage of sub-optimal models, *European Journal of Operational Research,* 197: 203–213. Link to pre-print at: http://info-gap.com/content.php?id=22

[7] ○ Lecture notes on Portfolio Management, \lectures\Econ-Dec-Mak\portfolio-mgt001.pdf, sections 1 and 2.
○ Ben-Haim, Yakov, *Info-Gap Decision Theory,* section 3.2.7: Portfolio investment.

[8] ○ Lecture notes on Portfolio Management, \lectures\Econ-Dec-Mak\portfolio-mgt001.pdf, section 3.
○ Yakov Ben-Haim, *Info-Gap Economics,* section 4.2: Value at Risk in Financial Economics.
○ Yakov Ben-Haim, 2005, Value at risk with Info-gap uncertainty, *Journal of Risk Finance,* vol. 6, #5, pp.388–403.

[9] ○ Lecture Notes on Info-gaps in Project Management Knowledge Areas, \lectures\p_mgt\pmbok01.tex
○ Lecture Notes on Project Planning of Price and Quality Under Uncertainty, lectures\p_mgt\price-qual01.tex
○ Ben-Haim, Yakov, *Info-Gap Decision Theory,* section 3.2.6: Project scheduling with uncertain task durations.
○ Yakov Ben-Haim and Alexander Laufer, 1998, Robust reliability of projects with activity-duration uncertainty, *ASCE Journal of Construction Engineering and Management.* 124: 125–132.

[10] \lectures\info-gap-methods\lectures\ro02.pdf, section 17.

[11] \lectures\info-gap-methods\lectures\ro02.pdf, section 15.

2. Fabrycky, W.J., G.J. Thuesen, and D. Verma, 1998, *Economic Decision Analysis,* 3rd ed., 1998, Prentice-Hall.
3. Png, Ivan and Dale Lehman, 2007, *Managerial Economics,* 3rd Edition, Wiley-Blackwell.

Supporting texts:

4. Ben-Haim, Yakov, 2006, *Info-Gap Decision Theory: Decisions Under Severe Uncertainty,* 2nd edition, Academic Press.
5. Ben-Haim, Yakov, 2010, *Info-Gap Economics: An Operational Introduction,* Palgrave-Macmillan.