Decisions under risk and uncertainty

Decisions under risk and uncertainty	
Offered by	Department of IE&IS
Language	English
Primarily interesting for	All students, particularly those for whom decision-making, safety and technological risk are important for their major subject (e.g., chemical engineering).
Prerequisites	Required courses: Recommended courses: USE Basic
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Content and composition

Students choose one of the two specialized courses in quarter 2.

Course code	Course name	Level classification
0LEUA0	Decisions Under Risk and Uncertainty Exploratory Course	Exploratory
0LSUA0	Analysis and Control of Risk	Specialized
0LSUC0	Introduction to Decision Theory	Specialized
0LAUH0	Decisions Under Risk and Uncertainty Project Course	Project/ application

Course description

0LEUA0 Decisions Under Risk and Uncertainty Exploratory Course

Many complex issues in engineering involve decision making under risk and uncertainty, whether by managers, technology users, or engineers themselves. In this challenge-based learning course, students explore cases involving real life problems of risk and uncertainty in technology. Examples include safety and risks factors associated with battery recycling, hydrogen production and storage, steam reforming, the introduction of a plasma plaster, privacy preserving contact tracing or key management.

All students take the exploratory course as the first course in the sequence.

Learning goals:

- The student is able to reformulate ill-structured research problems, and is able to explain and defend the reformulation to stakeholders.
- The student is able to find, interpret, and begin to apply theoretical concepts regarding safety, risk, and decision-making to an engineering problem.
- The student is able to conduct team-based case-study research;
- The student is able to describe and evaluate the current state of techno-scientific research pertaining to their topic using contemporary concepts of scientific evidence, scientific objectivity, and values in science.
- The student is able to formulate cogent arguments on the above issues using conceptual tools from decision theory, ethics, and philosophy of science
- The student is able to take a standpoint on a scientific argument regarding the USE aspects of technology, using evidence-based reasoning and reliable sources.

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0LSUA0 Analysis and Control of Risk

This is one of two possible specialized courses that students take as part of the sequence.

This course focuses on methods of identifying and analysing the risks associated with technical systems, such as FMEA, fault-tree analysis and human reliability assessment. Students also choose one of two additional short modules, focusing on either descriptive decision theory or information security. In the short descriptive decision theory module, students examine the psychology of human decision-making, including heuristics & biases, ecological rationality, prospect theory, and nudging. In the short information security module, students examine cryptographic security and privacy technology and policy.

Learning objectives
Students familiarize themselves with basic knowledge of theories, methods and techniques of risk assessment and analysis.
At the end of the course, students will be able to:

- identify risks of complex engineered systems, using FMEA and human reliability assessment methods;
- construct a probabilistic risk model, using fault-tree analysis and belief networks;
- perform a reliability analysis of system components; formulate a strategy for risk communication.

Students should also be familiar with some key concepts and applications of either descriptive decision theory or information security.
Students should be able to determine, and reason about, the applicability of these concepts to real-world problems arising from stakeholders.

0LSUC0 Introduction to Decision Theory

This is one of two possible specialized courses that students take as part of the sequence.

Objectives

Students should be familiar with, and able to apply, methods and theories for decision making under risk and ignorance, and they should be familiar with the key ideas of utility theory, objective and subjective interpretations of the probability calculus, pragmatic arguments, causal vs. evidential decision theory, Bayesian vs non-Bayesian decision theory, elementary game theory (two-person zero-sum games), backwards induction, and social choice theory. Students should also be familiar with some key concepts and applications of either descriptive decision theory or information security. Students should be able to determine, and reason about, the applicability of these concepts to real-world problems arising from stakeholders.

Content

Decisions under ignorance and risk, utility theory, objective and subjective interpretations of the probability calculus, pragmatic arguments, causal vs. evidential decision theory, Bayesian vs non-Bayesian decision theory, elementary game theory (two-person zero-sum games), backwards induction, social choice theory, prospect theory, information security.

Students are strongly recommended to take three courses in the Decisions Under Risk and Uncertainty learning line in sequence during a single year.

Students from an earlier year needing to retake the course may obtain credit under the same course code, but should consult with the instructor in the first week.

0LAUH0 Decisions Under Risk and Uncertainty Project Course

In this challenge-based learning course, students work toward an acceptable technical solution to a problem relating to (real-life) stakeholders, first encountered in previous courses in the sequence. Examples include safety and risks factors associated with battery recycling, hydrogen production and storage, steam reforming, the introduction of a plasma plaster, privacy preserving contact tracing or key management. Using theoretical and technical knowledge from the specialized course, students assess possible technical solutions for acceptability and develop solutions that are acceptable to relevant stakeholders/ clients. They communicate the proposed solution(s) to a stakeholder in a presentation at the end of the course.

Learning objectives

The student can work effectively and cooperatively as a member of a team, as well as manage their time toward a concrete self-generated objective, including making use of work planning and monitoring tools.

The student is able to define acceptability requirements for stakeholders in a way that is specific, measurable, achievable, and realistic.

The student can adapt a technical solution to a USE context in a way that shows sophisticated choice and application of technical tools.

The student is able to communicate in writing and orally about the development and acceptability of a technical solution to a USE problem with involved stakeholders as well as subject experts, and is able to explain and defend the acceptability of the solution.

The student is able to explain and defend the acceptability of a technical solution in a USE context, based on justifiable scientific criteria, ethical norms or theories, empirical evidence or policy claims.