<u>Module Title:</u> Decision Analysis and Knowledge Engineering (Compulsory)

- **Type of Module:**

x	PC (Prescribed Core Module)
	PS (Prescribed Stream Module)
	ES (Elective Stream Module)
	E (Elective Module)

- **Level of Module: Track Course**
- **Year of Study** 4th
- **Semester** 7th
- **Number of credits allocated** 5
- **Name of lecturer / lecturers :** Professor Georgios Dounias
- **Description:**

The course primarily refers to methods for decision-making under uncertainty and deals with analytical approaches in this respect. Topics covered include:

- decision making processes, decision trees, Bayes-theorem and Bayesian revision
- value of information, basic utility theory, multi-attribute decision making, construction and analysis of decision trees and influence diagrams using decision analysis software
- quantification of judgments, risk preferences, and degree of risk aversion via subjective expected utility

Generalizations of expected utility theory to problems in which consequences are descriptively complex and multi-attributed are illustrated with applications in engineering and management.
The course also teaches mathematical logic principles (propositional and categorical logic) as a basis for understanding rule based systems for decision support (expert systems, fuzzy rule based systems).
Furthermore the course contains introductory lectures to approximate reasoning, fuzzy decision analysis and computational intelligence-based approaches for the handling of uncertainty, in real-world problems (soft computing, fuzzy rule-based systems, neural computation, inductive machine learning, evolutionary computing – genetic programming, hybrid and adaptive intelligent schemes, nature inspired intelligence). Some lectures include demonstration of indicative algorithms and programs for computer assisted decision analysis.
Finally, the course contains a brief reference to other decision methodologies such as multi-criteria decision making, analytical hierarchical process, game-theory for strategic decision making, etc.

- **Prerequisites: None**
- **Module Contents (Syllabus):**

ΕΒΔΟΜΑΔΑ	ΠΕΡΙΕΧΟΜΕΝΟ ΜΑΘΗΜΑΤΟΣ
1	➢ Introduction to the Decision Making Process
2	➢ Types of Decisions / Data Analysis / Uncertainty
3	➢ Introduction to Mathematical Logic – Logic Operators

4	➢ Propositional Logic (Truth Tables – Logical Consequences – Laws – Normal Forms – Examples)
5	➢ Predicate Logic – Symbols – Laws of Predicate Calculus – Rpenex and Skolem Normal Forms – Examples
6	➢ Mechanical Theorem Proving – Herbrand Theorem – Resolution Principle – Solved Problems and Case Studies
7	➢ 1st Written Test
8	➢ Decisions under Uncertainty – Subjective Probabilities (Bayes) – Decision Trees – Raiffa's Basic Problem
9	➢ Utility Theory and Decision Trees – Risk and Utility Functions – Special Topics in Decision Analysis
10	➢ Solved Problems and Case Studies in Decision Analysis
11	➢ 2η Written Test
12	➢ Computational Methods for Decision Making (Inductive Learning and Inductive Decision Trees, Fuzzy Logic and Fuzzy Rule Based Systems) – Presentation of related algorithms and programs
13	➢ Evolutionary Computation and Decision Making – Neural Networks – Nature Inspired Intelligence – Other data driven decision making methodologies

- **Recommended Reading:**

A) Principal Reference:

Notes of the instructor (in Greek)

B) Additional References:

Other related references:

- *Decision Analysis*, Raiffa H., Addison-Wesley, 1968.
- *Decision Making with Multiple Objectives*, Keeney R., Raiffa H., Wiley, 1976.
- *Applied Decision Analysis,* Bunn D., McGraw-Hill, 1984.
- *C-L Chang, R C-T Lee (1973), Symbolic Logic and Mechanical Theorem Proving, Academic Press*
- Z. Chen (1999), Computational Intelligence for Decision Support, CRC Press

- **Teaching Methods:**

In class teaching, case study discussions

- **Assessment Methods:**

- Final exam 100%
- Two Written Tests (maximum bonus 20%)

- **Language of Instruction:** Greek

- **Module Objective (preferably expressed in terms of learning outcomes and competences):**

- Understanding of basic concepts in decision theory. Modeling of the decision making process. Handling of uncertainty. Computer Assisted Decision Making.
- Understanding the particularities of decision analysis methods. Preconditions for the proper adjustment of the methods taught in real decision problems. How to apply the proper method for each decision problem.
- The Knowledge and Decision Engineer: From the data collection process, to the design, implementation and application of the proper decision making methodology. Preconditions for elaborating a Diploma Thesis in the domain.

Module Objective (preferably expressed in terms of learning outcomes and competences):

- Understanding of basic concepts necessary for elaborating feasibility studies (cash-flow diagram representations, investment horizon, viewpoint of analysis, opportunity cost of capital, taxation, depreciation, inflation)
- Emphasis on the proper use of the four investment criteria for comparing mutual alternatives, under the unified methodological framework of incremental analysis
- Application of the above in solving real-world problems and case studies / analysis of the perspective of an engineering career in the field of consulting