Module Title: 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** 4<sup>th</sup>

- **Semester** 7<sup>th</sup>

- **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):**

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<td>Introduction to the Decision Making Process</td>
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- Propositional Logic (Truth Tables – Logical Consequences – Laws – Normal Forms – Examples)
- Predicate Logic – Symbols – Laws of Predicate Calculus – Rpenex and Skolem Normal Forms – Examples
- Mechanical Theorem Proving – Herbrand Theorem – Resolution Principle – Solved Problems and Case Studies
- 1st Written Test
- Decisions under Uncertainty – Subjective Probabilities (Bayes) – Decision Trees – Raiffa’s Basic Problem
- Utility Theory and Decision Trees – Risk and Utility Functions – Special Topics in Decision Analysis
- Solved Problems and Case Studies in Decision Analysis
- 2nd Written Test
- Computational Methods for Decision Making (Inductive Learning and Inductive Decision Trees, Fuzzy Logic and Fuzzy Rule Based Systems) – Presentation of related algorithms and programs
- 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:
  - 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 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