

## **SDM5002 - Systems Engineering**

Workload: 3-0-0-2-5

### **Description:**

Systems Engineering is an interdisciplinary approach to realize the successful creation of systems that meet customer and stakeholders requirements with due consideration of the system's performance and impact over the entire life-cycle. The module covers the fundamental methods and concepts of this approach including those to surface system requirements; architect options and alternatives; model systems; evaluate performance; and analyze tradeoffs.

### **Syllabus:**

1. Introduction to systems thinking and systems engineering  
Origins of system thinking; comparisons with linear thinking; basic principles; beyond first-use properties; concept of systems engineering; systems engineering activities.
2. Systems methodology  
Levels of thinking; hard and soft modeling; developing system requirements; soft systems methodology; cognitive mapping; identifying risk and strategic opportunity; developing and analyzing strategic options; cost estimation; decision analysis concepts; developing scenarios and system in use cases. Case Study.
3. System development and integration  
Vee model; decomposition and system definition; system component tests; system integration and verification.
4. Modeling systems  
Causal loop diagrams; feedback processes; system delays; time behavior of systems; system archetypes; transformation to a dynamic model; model validation and verification; reference mode; system complexity; scenario planning; case study.
5. Multi-criteria decision making.  
Process and stages of decision making; methods for generating non-dominated sets; assessment of priority weights – direct and indirect methods; Simple Multi-Attribute Rating Technique SMART; Additive and the Multiplicative AHP; Discrete multi-criteria methods - ELECTRE; PROMETHEE; group decision making. Case study.
6. Performance measurement  
Measures of efficiency and performance; data envelopment analysis – basic principles; constant returns to scale; variable returns to scale; assessing policy effectiveness; using value judgments. Case study.

**Text / References:**

1. Rosenhead, J. and John Mingers (eds).; Rational analysis for a problematic world revisited: problem structuring methods for complexity, uncertainty and conflict; 2nd ed. Chichester; New York : Wiley, 2001.
2. Morecroft, J., R. Sanchez and A. Heene (eds); Systems Perspectives on Resources, Capabilities, and Management Processes. New York: Pergamon, 2001.
3. Lootsma, F.A.; Multi-criteria decision analysis via ratio and difference judgement. Boston: Kluwer, 1999.
4. Maani, K.; Systems Thinking and Modelling: Understanding Change and Complexity. Prentice Hall, 2001.
5. Thanassoulis, E. Introduction to the theory and application of data envelopment analysis. Norwell, Mass.: Kluwer Academic Publishers, 2001.