COURSE SYLLABUS

Intelligent Optimization and Problem Solving, 7.5 credits

Intelligent optimering och problemlösning, 7,5 högskolepoäng

Course Code:	TIOS26	**Education Cycle:**	Second-cycle level
Confirmed by:	Dean Oct 15, 2024	**Disciplinary domain:**	Technology
Valid From:	Jan 1, 2026	**Subject group:**	DT1
Version:	1	**Specialised in:**	A1F
		Main field of study:	Computer Science

Intended Learning Outcomes (ILO)

After a successful course, the student shall:

Knowledge and understanding

• show familiarity with the fundamental concepts of combinatorial search, optimization, and declarative problem solving

• display knowledge of algorithmic optimization techniques and declarative problem-solving methods

• demonstrate comprehension of practical applications and current state-of-the-art in search and optimization for classical areas in AI in various industries

Skills and abilities

• demonstrate skills in modeling complex optimization problems and solving them using appropriate AI techniques

• demonstrate the ability to implement optimization approaches and evaluate their performance

• show proficiency in using state-of-the-art AI tools for optimization and declarative problem solving

Judgement and approach

• demonstrate the ability to critically analyze and compare different AI problem-solving techniques

• demonstrate the ability to approach problem-solving innovatively and propose novel solutions

Contents

This course equips students with advanced knowledge and practical skills in combinatorial optimization and declarative problem solving, preparing them to tackle complex challenges from classical areas of AI such as configuration, design, planning, scheduling, and diagnosis and across various industries. Students will gain a comprehensive understanding of declarative methods and meta-heuristic approaches, learning to model, optimize, and solve real-world problems using state-of-the-art tools and techniques. The course emphasizes hands-on experience and innovative thinking to foster adaptability in problem solving.

The course includes the following elements:

- **Part I: Declarative Problem Solving.** This part covers declarative methods for solving combinatorial optimization and search problems. Students will explore advanced modelling techniques, focusing on logic-based methods and constraint satisfaction. Examples of such methods are
  - answer-set programming
  - answer-set programming with integer constraints (e.g., clingcon, clingo-dl)
  - constraint programming and optimization tools (e.g., MiniZinc, Google OR-Tools, CPLEX).
- **Part II: Optimization by Intelligent Techniques.** This part focuses on heuristic and meta-heuristic approaches to optimization. Students will learn a variety of techniques and algorithms and apply them to solve complex problems efficiently. Such techniques include (but are not limited to)
  - heuristics and meta-heuristics,
  - evolutionary computation, and
  - swarm intelligence.

Type of instruction

The course comprises of several modes of instruction, such as lectures, mini-projects, and tutoring.

The teaching is conducted in English.

Prerequisites

Passed courses at least 90 credits within the major subject Computer Engineering, Electrical Engineering (with relevant courses in Computer Engineering), or equivalent, or passed courses at least 150 credits from the program Computer Science and Engineering, and taken courses in Artificial Intelligence, 7,5 credits, and Knowledge Representation and the Semantic Web, 7,5 credits, or equivalent. Proof of English proficiency is required.

Examination and grades

The course is graded 5,4,3 or Fail.

Registration of examination:

Name of the Test	Value	Grading
Project[I]	2.5 credits	5/4/3/U
Assignments	5 credits	U/G

[I] Determines the final grade of the course, which is issued only when all course units have been passed.

Course literature

The literature list for the course will be provided eight weeks before the course starts.

The principal texts are:
Title: Answer set solving in practice.

Author: Gebser, M., Kaminski, R., Kaufmann, B., & Schaub, T.
Publisher: Springer Nature.
ISBN: 3031015614, 9783031015618

Title: How to solve it: modern heuristics, 1st ed.
Author: Michalewicz, Z., & Fogel, D. B.
Publisher: Springer Science & Business Media
ISBN: 978-3-662-04131-4

Title: Introduction to Evolutionary Computing, 2nd ed.
Author: Eiben, A. E., & Smith, J. E.
Publisher: Springer Berlin, Heidelberg
ISBN: 978-3-662-49985-6

Title: Theory and Principled Methods for the Design of Metaheuristics, 1st ed.
Author: Borenstein, Y., & Moraglio, A.
Publisher: Springer Berlin, Heidelberg
ISBN: 978-3-662-51955-4