Content

Course Code	Course Name	Semester	Theory	Practice	Lab	Credit	ECTS
IT 542	Innovative Algorithms	2	4	0	0	3	8

Prerequisites	
Admission Requirements	
Language of Instruction	English
Course Type	Compulsory
Course Level	Masters Degree
Objective	The aim of this course is to teach students the fundamental concepts, types, and applications of algorithms, and to develop their skills in algorithm design and analysis. The course seeks to bridge the gap between algorithm theory and practical applications. Students will understand when and for what purposes algorithms should be used, and will be able to identify the appropriate class of algorithms to solve a given problem. Another objective is to raise students' awareness of the social impacts of algorithms and their potential biases or unfairness.
Content	1. Fundamentals of algorithms, their role in everyday life, history, types of algorithms, definition of execution time, computational complexity. 2. Algorithm complexity analysis, time and space complexity, best, average, and worst-case analyses with examples. 3. Basic algorithms and decision-making mechanisms (randomized algorithms, sorting and searching algorithms, best-first search, A*, minimax algorithm). 4. Fundamental graph and shortest path algorithms, minimum spanning tree algorithms (traversal algorithms, Dijkstra, Bellman-Ford, Floyd-Warshall). 5 Heuristic and metaheuristic algorithms (local search, simulated annealing, tabu search). 6. Evolutionary algorithms (genetic algorithm, particle swarm optimization, ant colony optimization, artificial bee algorithm). 7. Dynamic programming, greedy algorithms. 8. Midterm exam. 9. Planning algorithms: basic decision theory, game theory, reinforcement learning, decision-making under uncertainty. 10. Algorithm ethics, fairness, and open problems. 11. Student projects.
References	1. T.H. Cormen, C.E. Leiserson, R.L. Rivest, C. Stein, Introduction to Algorithms, 4th edition, The MIT Press; (April 5, 2022). 2. S.M. LaValle, Planning Algorithms, Cambridge University Press; Illustrated edition (May 29, 2006). 3. A. Bhargava, Grokking Algorithms: An illustrated guide for programmers and other curious people, Manning Publications; 1. basım (31 Aralık 2015).

Theory Topics

Week	Weekly Contents
1	Fundamentals of algorithms, their role in everyday life, history, types of algorithms, definition of execution time, computational complexity.
2	Algorithm complexity analysis, time and space complexity, best, average, and worst-case analyses with examples.
3	Basic algorithms and decision-making mechanisms (randomized algorithms, sorting and searching algorithms, best-first search, A*, minimax algorithm).
4	Fundamental graph and shortest path algorithms, minimum spanning tree algorithms (traversal algorithms, Dijkstra, Bellman-Ford, Floyd-Warshall).
5	Heuristic and metaheuristic algorithms (local search, simulated annealing, tabu search).
6	Evolutionary algorithms (genetic algorithm, particle swarm optimization, ant colony optimization, artificial bee algorithm).
7	Dynamic programming, greedy algorithms.
8	Midterm exam.
9	Planning algorithms: basic decision theory, game theory, reinforcement learning, decision-making under uncertainty.
10	Algorithm ethics, fairness, and open problems.
11	Student projects.