Content

Course Code	Course Name	Semester	Theory	Practice	Lab	Credit	ECTS
IND 504	Heuristic Methods For Optimization	2	3	0	0	3	6

Prerequisites	
Admission Requirements	

Language of Instruction	English
Course Type	Elective
Course Level	Masters Degree
Objective	This course aims to equip students with the ability to develop versatile and innovative solution strategies for complex and large-scale optimization problems. The primary goal is to introduce the theoretical foundations of heuristic and metaheuristic methods and demonstrate their advantages in various scenarios through concrete examples. The course covers a broad spectrum, from computational complexity to constructive and improvement heuristics, population-based approaches, and modern algorithms in the literature. By the end of the course, students will acquire the necessary knowledge to generate efficient solutions for various academic and industrial optimization problems. Presentations and term projects play a central role in bridging theoretical knowledge with practical applications. Students will implement metaheuristic algorithms for specific optimization problems, quantitatively and qualitatively evaluate their results, and develop a critical perspective on the strengths and weaknesses of different methods. In this process, they will gain experience in algorithm design and performance analysis and learn how to develop new methods or hybridize existing ones. Thus, the course aims to prepare students for advanced academic research as well as the ability to provide effective solutions for complex industry problems.
Content	1. Week: Computational Complexity, Heuristic and Metaheuristic Methods 2. Week: Constructive Heuristics 3. Week: Improvement Heuristics 4. Week: Simulated Annealing, Tabu Search 5. Week: Genetic Algorithms, Differential Evolution Algorithm 6. Week: Particle Swarm Optimization, Ant Colony Optimization 7. Week: Whale Optimization Algorithm, Grey Wolf Optimization 8. Week: Flower Pollination Algorithm, Dragonfly Algorithm 9. Week: Harmony Search Algorithm, Gravitational Search Algorithm 10. Week: Hybridization of Metaheuristic Methods 11. Week: Constraint Handling Approaches 12. Week: Performance Evaluation of Heuristics 13. Week: Term Project Presentations 14. Week: Term Project Presentations

References	1. Gendreau, M., & Potvin, J.-Y. (Eds.). (2019). Handbook of Metaheuristics (3rd ed.). Springer International Publishing. 2. Martí, R., Pardalos, P. M., & Resende, M. G. C. (Eds.). (2018). Handbook of Heuristics. Springer International Publishing. 3. Maniezzo, V., Boschetti, M. A., & Stützle, T. (2021). Matheuristics: Algorithms and Implementations. Springer International Publishing. 4. Talbi, E.-G. (2009). Metaheuristics: From design to implementation. John Wiley & Sons. 5. Blum, C., & Raidl, G. R. (2016). Hybrid metaheuristics: Powerful tools for optimization. Springer International Publishing. 6. Kulkarni, A. J., Mezura-Montes, E., Wang, Y., Gandomi, A. H., & Krishnasamy, G. (Eds.). (2021). Constraint handling in metaheuristics and applications. Springer. 7. Michalewicz, Z., & Fogel, D. B. (2004). How to solve it: Modern heuristics. Springer. 8. Kaveh, A., & Bakhshpoori, T. (2019). Metaheuristics: Outlines, MATLAB codes and examples. Springer Nature Switzerland. 9. Taillard, É. D. (2023). Design of heuristic algorithms for hard optimization: With Python codes for the traveling salesman problem. Springer Nature.

Theory Topics

Week	Weekly Contents
1	Computational Complexity, Heuristic and Metaheuristic Methods
2	Constructive Heuristics
3	Improvement Heuristics
4	Simulated Annealing, Tabu Search
5	Genetic Algorithms, Differential Evolution Algorithm
6	Particle Swarm Optimization, Ant Colony Optimization
7	Whale Optimization Algorithm, Grey Wolf Optimization
8	Flower Pollination Algorithm, Dragonfly Algorithm
9	Harmony Search Algorithm, Gravitational Search Algorithm
10	Hybridization of Metaheuristic Methods
11	Constraint Handling Approaches
12	Performance Evaluation of Heuristics
13	Term Project Presentations
14	Term Project Presentations