

# IE 505 HEURISTIC SEARCH

Fall 2024

**Instructor:** Nader Ghaffarinasab, IE 332, [naderg@metu.edu.tr](mailto:naderg@metu.edu.tr), 210 2267

**Course webpage:** <https://odtuclass.metu.edu.tr>

**Lecture hours:** TBA

**Course objective:** To cover various (meta)heuristic search approaches for solving combinatorial optimization problems.

**Course conduct:** The course material consists of some book chapters and journal articles. The basic material on the methods and techniques will be covered through regular lectures. The students will present some application papers as well as their projects. Students are required to come to class well-prepared and expected to actively participate in class discussions.

**Background:** Basic knowledge of combinatorial optimization, familiarity with a programming language (e.g., C++, JAVA, Python, etc.), and being comfortable with using a mathematical programming software (e.g., GAMS, CPLEX, Gurobi, etc.)

## Outline:

- 1- Introduction
- 2- Categorization of heuristic algorithms
- 3- Construction heuristics
- 4- Improving/Local search heuristics
- 5- Metaheuristics:
  - Simulated annealing
  - Tabu search
  - Genetic algorithm
  - Swarm intelligence and ant colonies
- 6- Handling of constraints
- 7- Metaheuristics for multi-objective optimization
- 8- Performance evaluation of heuristic algorithms
- 9- Computational complexity analysis
- 10- Matheuristics

**Grading:** Evaluation of students will be based on

- |  |     |
|--|-----|
| – Paper presentation and participation | 15% |
| – Assignments                          | 15% |
| – Project (in groups of two students)  | 40% |
| – Final exam                           | 30% |

### **Selected Books:**

- Talbi, E. G. (2009). Metaheuristics: from design to implementation. John Wiley & Sons.
- Gendreau, M., & Potvin, J. Y. (Eds.). (2010). Handbook of metaheuristics. New York: Springer.
- Michalewicz, Z., & Fogel, D. B. (2013). How to solve it: modern heuristics. Springer Science & Business Media.
- Edelkamp, S., & Schrod, S. (2011). Heuristic search: theory and applications. Elsevier.
- Talbi, E. G. (Ed.). (2013). Metaheuristics for bi-level optimization. Springer Berlin Heidelberg.
- Blum, C. & Merkle, D. (2008) Swarm Intelligence: Introduction and Applications. Springer.
- Dasgupta, D. & Michalewicz, Z. (1997). Evolutionary Algorithms in Engineering Applications. Springer.
- Maniezzo, Boschetti, & Stutzle. (2021). Matheuristics: Algorithms and Implementation. Springer.
- Reinelt, G. (1994). The Traveling Salesman: Computational Solutions for TSP Applications. Springer-Verlag.

**Course Project:** The project is expected to be an original research paper, possibly an application of a heuristic search technique to an optimization problem or an extensive literature survey with substantial comparative discussion. It could take another form agreed upon by the instructor and the student. Deadlines for submitting the project proposal and the final report will be announced later.

**Make-up Exam Policy:** If you are absent from an exam, you must supply documented proof of a medical condition approved by METU Health Office, or you will receive zero credit.

**\*\* The right to make changes to the grading scheme is reserved, especially the number of assessment tools and the percentages allocated to each exam and other assessment tools.**