Selected Topics on Optimization (*Temas Selectos de Optimización*)

Introduction to Combinatorial Optimization

Spring 2026
Tuesday 09:30-12:00 (M4-M6) Classroom 9301

Professor: Dr. Roger Z. Ríos.

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TA: Dra. Leticia Vargas (E-mail: *leti.vargas.suarez@gmail.com*)

Dates: Classes: Tue 20-Jan to Tue 19-May (16 weeks).

Objective: The goal of this course is to introduce the combinatorial optimization discipline and to develop a basic understanding on modeling and solution techniques and methods used to solve this type of decision-making problems. The course has two parts. In the first part, basic theory and fundamentals of combinatorial optimization will be addressed. These will be further illustrated throughout a collection of classical problems such as the Knapsack Problem and the Traveling Salesman Problem. Constructive heuristics will be introduced as well. In the second part, local search heuristics will be covered. All heuristics techniques will be applied to a diversity of combinatorial optimization problems.

Pre-requisites: **Solid** knowledge and experience in a high-level programming language such as C, C++, Java, python. **Excellent English skills** (listening, reading, writing, and speaking).

Texts: A. Díaz, F. Glover, H.M. Ghaziri, J.L. González, M. Laguna, P. Moscato, F.T. Tseng (editors). *Optimización Heurística y Redes Neuronales*. Editorial Paraninfo, Madrid, España, 1996.
R. Martí. *Algoritmos heurísticos en optimización combinatoria*. Technical report, Departamento de Estadística e Investigación Operativa, Universitat de Valencia, Valencia, Spain, 2004. URL: http://yalma.fime.uanl.mx/~roger/work/teaching/class_tso/docs/1-Introduction/

Supporting texts: F. Glover, G.A. Kochenberger (editors). *Handbook of Metaheuristics*. Kluwer, Boston, USA, 2003.
E.L. Lawler, J.K. Lenstra, A.H.G. Rinnooy Kan, D.B. Shmoys (editors). *The Traveling Salesman Problem: A Guided Tour of Combinatorial Optimization*. Wiley, Chichester, UK, 1985.
S. Martello, P. Toth. *Knapsack Problems: Algorithms and Computer Implementations*. Wiley, Chichester, UK, 1990.
C.H. Papadimitriou, K. Steiglitz. *Combinatorial Optimization: Algorithms and Complexity*. Prentice Hall, Englewood Cliffs, USA, 1982.

Online platform: When needed or scheduled, virtual classes will be given through the MS-TEAMS platform as scheduled. Please connect at least 5 minutes before. It is mandatory to have a computer, internet access, and microphone/camera in working condition. Attendance will be taken.

Web site: URL: *http://yalma.fime.uanl.mx/~roger/work/teaching/*

Mailing list: To subscribe, send the message: subscribe fime_tso [*your name*]
to: *sympa@utlists.utexas.edu*
E-mail (for posting): *fime_tso@utlists.utexas.edu*

Grades:

(A1) Homework 1	5 %	
(A2) Homework 2	5 %	
(A3) Homework 3	5 %	
(A4) Mid-term exam (**)	20 %	(M 09-Mar-2026)
(A5) Project - report (teams)	20 %	(F 15-May-2026)
(A6) Project - presentation (teams)	5 %	(T 12-May-2026)
(A7) Final (ordinary) exam (**)	25 %	(M 25-May-2026)
(A8) Project - proposal (teams)	5 %	(T 03-Mar-2026)
(A9) Homework 4	5 %	
(A10) Attendance (*)	5 %	

(*) A 95% minimum attendance is worth 5 points, 90% minimum attendance is worth 4 points, less than 90% attendance is worth 0 points. (**) A minimum of 80% attendance rate is required to have the right to take each of the mid-term and final exams.

Homeworks: Homeworks are individual. Failure to turn in homework by its due date has a grade of 0. No late homeworks allowed.

Project: Proposal and final project (written report and oral presentation) will be done in teams. Details will be provided later.

Exams: No late exams allowed. Exam no-shows get an NP grade and is averaged out as zero. No extra time will be given to late arrivals. A student taking the course on first opportunity earns a right to take the extraordinary (second opportunity) exam as long as he/she fulfills at least 70% (5 out of 7) of the fundamental activities (A1)-(A7).

Remarks: The use of mobile phones **is strictly prohibited** in classroom. First offense gets a one-week phone suspension, second offense gets one month.

Topics

Unit 1: Introduction to Combinatorial Optimization (CO)

- Definitions and basic concepts
- Problem models and structures
- Classic CO models
- Computational complexity of combinatorial problems
- Introduction to constructive heuristic methods
- The Knapsack Problem (definition and classic constructive heuristics)
- The Traveling Salesman Problem (definition and classic constructive heuristics)

Unit 2: Solution methods

- Introduction to local search heuristic methods
- The Knapsack Problem (local search heuristics)
- The Traveling Salesman Problem (local search heuristics)
- Application of heuristics to other combinatorial optimization problems
- Basic concepts of multi-start randomized heuristics

Schedule:

Week	Lecture Date	Remark
1	20 / Jan	First lecture day
2	27 / Jan	HW1 given (due 03/Feb)
3	03 / Feb	HW2 given (due 17/Feb)
4	10 / Feb	The Draw
5	17 / Feb	HW2 presentation
6	24 / Feb	HW3 given (due 09/Mar)
7	03 / Mar	Project proposals due
8	09 / Mar	(Monday) Mid-term exam
9	17 / Mar	Bye (mid-term week)
10	24 / Mar	
	30 / Mar - 12 / Apr	Spring break
11	14 / Apr	HW4 given (due 21/Apr)
12	21 / Apr	
13	28 / Apr	
14	05 / May	Bye
15	12 / May	Presentation of team projects (reports due F 15-May)
16	19 / May	Last lecture
	25 / May	(Monday) Final exam
	05 / Jun	(Friday) Extraordinary exam

Color Code

Exam date	**Bye (midterms)**	**Bye (academic calendar)**

Note: Exams are taken closed notes/book unless otherwise noted