The Optimization for Applied Engineering Design course is aimed at providing the participants with knowledge in applied optimization, with focus on the application of theory and methods in deterministic optimization and heuristic techniques for modeling and solving optimization problems originating from the area of communication and others areas.

### Learning objectives of the subject

The Optimization for Applied Engineering Design course is aimed at providing the participants with knowledge in applied optimization, with focus on the application of theory and methods in deterministic optimization and heuristic techniques for modeling and solving optimization problems originating from the area of communication and others areas.
### Introduction to Optimization

**Description:**
Definition of an Optimization Problem. Unconstrained and Constrained Optimization.

**Related activities:**
Problems resolution  
Control

**Specific objectives:**
- Definition of an Optimization Problem  
- Components of an Optimization Problem

- Unconstrained Optimization  
- Statement of an Optimization Problem  
- Concepts  
- Concavity and Convexity  
- Conditions for local optimizers: Interior and Boundary cases

- Equality Constrained Optimization  
- Conditions for local optimizers

- Inequality and Equality Constrained Optimization  
- Conditions for local optimizers

<table>
<thead>
<tr>
<th>Learning time:</th>
<th>15h</th>
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<tbody>
<tr>
<td>Practical classes:</td>
<td>5h</td>
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<tr>
<td>Self study:</td>
<td>10h</td>
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</table>
Part I: Optimization with Engineering Applications

**Description:**
Network Optimization
Mixed Integer Programming
Multi-Objective Optimization

**Related activities:**
Lab learning sessions
Laboratory Project sessions
Control

**Specific objectives:**
* Network Optimization
  - Special type of linear Programming
  - Continuous and Discrete Models
* Mixed Integer Programming
  - Common IP Problems- Technique for formulating CO problems as ILP
  - Linearizing nonlinear functions
* Multi-Objective Optimization
  - Definition of a MOP
  - Pareto Optimal Solutions
  - Solving Multi-objective Optimization Problems

**Learning time:** 48h
  - Practical classes: 18h
  - Self study: 30h
### Part II: Metaheuristics Optimization Algorithms

**Description:**
Introduction
Analysis of different algorithms

**Related activities:**
Lab learning session
Laboratory Project session

**Specific objectives:**
* Introduction

* Analysis of different algorithms depending on the progress of the course
  - Evolutionary Algorithms
  - Genetic Algorithms
  - Differential Evolution Algorithms
  - Ant Colony Optimization
  - Particle Swarm Optimization
  - Biogeography-based Optimization

<table>
<thead>
<tr>
<th>Learning time: 12h</th>
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<tbody>
<tr>
<td>Practical classes: 4h</td>
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<tr>
<td>Self study : 8h</td>
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### Part III. Computational complexity

**Description:**
Analysis of the computational complexity of an optimization problem

**Related activities:**
Problems resolution
Control

**Specific objectives:**
Basic Complexity classes
Intractable Problems. NP and NP completeness
Algorithmic complexity in Python

<table>
<thead>
<tr>
<th>Learning time: 7h 30m</th>
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<tbody>
<tr>
<td>Practical classes: 2h 30m</td>
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<tr>
<td>Self study : 5h</td>
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Part IV. Optimization Case Studies

<table>
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<th>Description:</th>
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<tr>
<td>Students will work on a given case study including the tasks needed to understand the problem, work out the details, find a viable way to attack the problem and implement a solution through a mathematical model and a heuristic.</td>
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</tbody>
</table>

Learning time: 42h 30m
- Practical classes: 14h
- Self study: 28h 30m

Qualification system

Lab learning Sessions 20%
Laboratory Project 20%
Mid-course control 20%
Case Study Analysis and Development 20%
Final exam 20%

Bibliography

Basic:

Complementary: