Optimization and application to control

ECTS credits
3 credits

In brief

Course langage: French

Presentation

Prerequisites

Mathematics: differential calculus

Learning objectives

Optimization methods are applied in a large number of fields related to engineering sciences, either as simple numerical analysis tools or from a dynamic point of view, such as optimal control problems.
The objective of this course is to present the theoretical aspects of static optimization without constraints, then with constraints (Lagrangian, KKT, saddle points and duality), as well as the main optimization algorithms (the gradient, the conjugate gradient, Newton, quasi-Newton...). The stochastic aspects of optimization will be discussed with the use of simulated annealing and cross-entropy.
This first part aims at introducing the notions of static optimization, in order to extend them to dynamic optimization and optimal control problems in a second part. The second part will be dedicated to Hamilton's equation, Pontryagin's principle of minimum, Bellman's principle of optimality. This will lead to the Riccati equation and the resolution of algebraic-differential equations. Different illustrative examples will be treated.

Description of the programme

The course is composed of two parts.
Part I deals with static optimization, it aims to acquire the following notions:
- mathematical notions, definition and choice of criterion, unconstrained optimization, constraint definition and constrained optimization, algorithms / numerical methods, stochastic aspects, towards identification.
Part II deals with dynamic optimization and optimal control; it aims at acquiring the following notions:

- choice of criterion, dynamic constraints, Hamilton's equation, Pontryagin's principle of optimality, dynamic programming and Bellman's optimality, Riccati's equation, towards optimal control.

Generic central skills and knowledge targeted in the discipline

The continuous assessment aims at the acquisition of the following competences:
- C1 Theme 1: intermediate level
- C1 Theme 2 : novice/intermediate level

The evaluation and the continuous assessment aim at the acquisition of the following competences
- C2 Theme 1 : competent level
- C2 Theme 2 : intermediate level

How knowledge is tested

The MCCs are broken down into two parts:
- 66% written evaluation of 2 h without document, calculator allowed
- 34 % report of the two practical exercises (static optimization and dynamic optimization)

Bibliography

– G. Allaire et S.M. Kaber, Algèbre linéaire numérique, Ellipses, 2002
– P.G. Ciarlet, Introduction à l'analyse numérique matricielle et à l'optimisation, Dunod, 1998
– M. Bergounioux, Optimisation et contrôle des systèmes linéaires, Dunod, 2001
– B. d'Andréa-Novel et M. Cohen de Lara, Cours d'automatique, commande linéaire des systèmes dynamiques, École des Mines de Paris, 2000

Teaching team

- Guillaume Graton
- Samia Mellah
- Dima El Jamal

Total des heures		**38h**
CM	Master class	14h
TD	Directed work	10h
TP	Practical work	14h

Useful info

Name responsible for EU

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