

System design



Component
École Nationale
Supérieure
d'Électrotechnique
d'Électronique

In brief

- > **Amety's Code:** N9EE21A
- > **Open to exchange students:** Yes

Presentation

Objectives

- Learn about the mathematical optimization methods available to engineers for the automatic optimal design of electrical engineering systems
- Raise awareness among future engineers of the systemic approach to the design of electrical energy devices.
- Present a methodological approach to modeling and systemic analysis based on Bond Graph Causal formalism.
- Apply this approach to the field of electrical energy for multi-physical systems and present a set of model classes (static converters, electrical machines, accumulators, etc.) geared toward the systems approach.
- The objective of this design office is to model an electro-hydrostatic actuator (EHA) using the Bond-Graph modeling tool and then replace the power source for this actuator with a fuel cell hybridized with supercapacitors.

Description

1.1 Design by optimization

- Introduction to optimization: Context and importance of optimization / Formulation of an optimization problem / Classification of optimization methods

- One-dimensional optimization methods: Interval methods (dichotomy, Fibonacci, golden ratio) / Interpolation methods / Search for the zero crossing of the derivative - Multidimensional optimization methods: Analytical methods: gradient, accelerated gradient, conjugate gradient, Gauss-Newton, Quasi-Newton (BFGS, DFP) / Geometric heuristics: Gauss-Seidel, Powell, Hooke & Jeeves, Nelder & Mead methods / Stochastic methods: Random Walk, simulated annealing, evolutionary algorithms, nesting methods, particle swarms
- Constrained optimization: Formalization of the Lagrangian / KKT optimality condition / Penalty methods
- Multi-objective optimization: Pareto optimality / Classification of multi-objective optimization methods / Weighting methods, ideal objective, bounded objectives, lexicographic, fuzzy logic
- Applications in electrical engineering: Optimization of a high-voltage connector / Parameter identification / Optimal sizing of a hybrid locomotive / Optimization of a passive wind chain

1.2 System design

- Awareness of the system approach: context, challenges, and characteristics of system design.
- Methodological approach: the Causal Bond Graph, Field of application: modeling in electrical engineering for systemic analysis.
- Examples of models for static converters, electrical machines, storage components, and their combinations

1.3 "BE EHA" system design

- Modeling the EHA using the Bond Graph tool
- Study of system causality - Determination of the transfer function using the established Bond Graph diagram
- Sizing of a hybrid system based on fuel cells and supercapacitors for powering the EHA
- Energy management of the hybrid system: frequency-based approach