DESIGN OPTIMAL ET MÉCANIQUE DES FLUIDES NUMÉRIQUE

OPTIMAL DESIGN AND COMPUTATIONAL FLUID DYNAMICS

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| Lecturers : 16.0 | TC : 0.0 | PW : 0.0 | Autonomy : 0.0 | Study : 16.0 | Project : 0.0 | Language : AN

Objectives

The course is devoted to the presentation and the practical application of a panel of numerical techniques currently used by the engineer to perform the optimal design of fluidic devices (shape optimization, optimal choice of design parameters of geometrical or other nature). The course displays two key original features:
- the described techniques are systematically linked with the CFD tools available for the engineer, with a distinction between open-source (modifiable) tools and close (commercial) codes.
- the presentation progresses from problems where a large quantity of information is available for the design (numerous values of objective functions and gradients) to problems where only a very limited amount of

Keywords : gradient-based optimization, adjoint approach, direct search, ideal multi-objective optimization, genetic algorithms, metaheuristics, surrogate models, robust optimization

Programme

1. Gradient-based optimization in CFD. Finite-difference estimate and adjoint approach. Extension to multi-objective problems. BE#1 & #2 : solution of model and engineering problems.
2. Gradient-free optimization. From direct search to metaheuristics. Ideal multi-objective optimization. BE#3, #4 &#5 : solution of model and engineering problems (heat exchanger, wind farm); start of the project.
3. Derivation of surrogate models for high-cost objectives. BE#6, #7 : solution of a shape optimization or a power maximization problem.
4. Key concepts of robust optimization. Uncertainty quantification and propagation

Learning outcomes

- Develop a good overview of current key optimal design problems in aerospace and energy engineering
- Be able to select and apply an optimization technique relevant for the design problem at hand
- Know how to apply a surrogate model in order to limit the cost of an optimization process
- Be able to take into account uncertainties on some design parameters

Independent study

Objectifs : Develop the ability to apply the optimization techniques described in the course and the ability to perform a critical analysis of the results obtained for an open engineering optimization problem.

Méhodes : Optimization project performed in an autonomous way by group of 2 students. Use of the tools (Matlab, specific codes) made available on the work stations of the computer rooms.

Core texts

K. Deb, *MULTI-OBJECTIVE OPTIMIZATION USING EVOLUTIONARY ALGORITHMS*, John Wiley & Sons, 2008
A. Forrester, A. Sobester *ENGINEERING DESIGN VIA SURROGATE MODELLING : A PRACTICAL GUIDE*, Wiley, 2008
P. Siarry*METAHEURISTIQUES*, Eyrolles, 2014

Assessment

Final mark = 50% Knowledge + 50% Know-how
Knowledge = 100% final exam
Know-how = 100% project