Labex Interactifs

Labex INTERACTFS (https://labex-interactifs.pprime.fr/)

2020 Projet Proposition d'un module de cours à destination des doctorants

I. Informations générales :

Employeur de l'intervenant ***Employer***	☐ **UP** ☐ **ENSMA** ☒ **CNRS**
TITRE du cours en français ***French title***	**CONTRÔLE DES ÉCOULEMENTS ET DES TRANSFERTS THERMIQUES**
TITRE du cours en anglais ***English title***	**CONTROL OF FLOWS AND HEAT TRANSFERS**
Adéquation avec les thèmes du Labex ***Adequacy with Labex Research project topics***	☐ 1 - COUPLAGE ENTRE LES MATÉRIAUX ET DES CONDITIONS SPÉCIFIQUES D'ENVIRONNEMENT ☐ 2 - FONCTIONNALISATION DES SURFACES ☒ 3- FLUIDES ET PHÉNOMÈNES ÉLECTRIQUES AUX INTERFACES
Enseignant ***Teacher***	**Nom :** CORDIER **Prénom :** Laurent **Tel :** 05 49 49 69 22 **Email : Laurent.Cordier@univ-poitiers.fr**
Modalités ***Terms and conditions***	**Date limite de candidature :** 30 janvier 2021 **Envoi du formulaire à l'adresse :** labex.interactifs@univ-poitiers.fr **Prendre contact avec les responsables de thèmes:** Cf tableau ci dessous*

Jours	Horaire	salle

II. Brève description du cours proposé, objectifs et plan

Control of flows and heat transfers

Course proposal – Labex INTERACTIFS

10 h

Lecturer: Laurent CORDIER (Laurent.Cordier@univ-poitiers.fr) - Directeur de Recherche CNRS – Directeur du GDR « Contrôle des Décollements » Pprime UPR 3346.

Language: This course may be given in English depending on the audience.

Optimization is at the center of many scientific and/or societal issues (understanding and modeling of complex physical phenomena, improvement of system performance, reduction of noise or pollution, machine learning, ...). The objective of this course is to present the concepts and tools (mainly numerical) necessary to approach in a modern way the control of flows and heat transfers. First, we will introduce the optimal control methods by showing the diversity of problems that can be solved in this framework. We will then present the essential elements of analysis and control of linear systems (LQR and LQG methods). We will illustrate these different methods on examples from fluid mechanics and thermal transfers.

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1/ Introduction.

2/ Optimal control (open-loop).

- 2.1/ Constrained optimization in finite dimension for time independent systems.
- 2.2/ Gradient methods based on sensitivities.
- 2.3/ Variational formulation.
- 2.4/ Gradient methods based on adjoint equations.
- 2.5/ Constrained optimization in finite dimension for time dependent systems.
  - 2.5.1/ Illustration: Optimal Energy Growth.
  - 2.5.2/ Illustration: Terminal Time Control by Unsteady Forcing.

2.6/ Constrained optimization of a space-time system by adjoint methods.

2.6.1/ Illustration: Determination of the adjoint Navier-Stokes equations.

2.7/ Introduction to variational data assimilation.

3/ Analysis of linear systems.

3.1/ State space representation of dynamical systems.

3.2/ Linear state representation.

3.2.1/ Illustration: Orr-Sommerfeld/Squire system.

3.3/ Commandability and observability.

3.4/ Balanced representation.

4/ Closed-loop linear control with full information.

4.1/ Linear Quadratic Control (LQR). Riccati equations.

4.1.1/ Illustration: Control of a stable non-normal linear system modeling a transient energy growth.

4.1.2/ Illustration: Control of the heat equation.

5/ Linear closed-loop control with state estimation.

5.1/ Reminder on stochastic processes.

5.2/ Estimation and Kalman filter.

5.3/ Linear Gaussian control (LQG). Principle of separation.

Notions can be illustrated using reduced-order models. Model reduction techniques are covered in the course "Model reduction for fluid mechanics and heat transfer".

From flow control to biomimetism. After Franck Fish.