2SC8110 – Multiphysical couplings for additive manufacturing

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Department: DÉPARTEMENT MÉCANIQUE ENERGÉTIQUE PROCÉDÉS
Language of instruction: ANGLAIS
Campus: CAMPUS DE PARIS - SACLAY
Workload (HEE): 60
On-site hours (HPE): 34,50

Description
This course will cover in a broad sense the concepts and challenges of multiphysical coupling.

Quarter number
ST7

Prerequisites (in terms of CS courses)
To have completed the "continuum mechanic" SSI course and at least one of the following courses: Materials, Transport phenomena, Thermodynamics.

Syllabus
This course will cover in a broad sense the concepts and challenges of multiphysical coupling.
The following topics will be adressed:

- Strong - weak coupling;
- Coupling of different formulations;
- Coupling of different scales.

Then particular coupling, of interest for additive manufacturing will be studied in more details:

- Laser on powder: electro-thermal coupling
- Powder bed melting: discrete-continuous coupling, solid-fluid coupling and thermo-mechanical coupling
- Cooling phase: aerothermal-mechanical coupling

The course will end with a reflection on the mechanical behavior of the final part (influence of residual stress, porosity, microstructure...)

Class components (lecture, labs, etc.)
8 lessons of 1h30 and 14 tutorials and case study sessions of 1h30.

Grading
The knowledge will be tested by a MCQ (multiple-choice questionnaire) (=N1) and the skills acquired will be tested by a case study in groups of 3 consisting in implementing a coupled system both analytically and by finite element modeling on comsol (N2=80%group result + 20%individual note). NF=max(100%N2 ; 30%N1 + 70%N2)

Course support, bibliography
- Zhang, Qun, and Song Cen, eds. "Multiphysics Modeling: Numerical Methods and Engineering Applications". Tsinghua University Press Computational Mechanics Series. Elsevier, 2015. https://univ-scholarvox-com.ezproxy.universite-paris-saclay.fr/catalog/book/docid/88831751?searchterm=multiphysics
- Peksen, Murat. "Multiphysics Modeling: Materials, Components, and Systems". Academic Press, 2018

Resources
The following digital tools will be used to support the course: COMSOL

Learning outcomes covered on the course

- Master the different types of coupling;
- Know how to choose a modeling strategy in a multiphysics system;
- Know how to formulate a model integrating a coupling.
- Know how to simulate this coupling in COMSOL and use the software in a relevant way to draw conclusions on how to optimize the system

Description of the skills acquired at the end of the course

- C2 Develop in-depth skills in an engineering field and a family of professions
- C6 Be operational, responsible, and innovative in the digital world
- C7 Know how to convince