1SC4510 – Introduction to Digital Twin

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

Description

The concept of digital twin qualifies an object that exists in the real world and that is modeled by its twin in a virtual world. The digital twin contains all the information of the physical system it represents (geometry, electrical networks, electronics, thermic properties, embedded software ...) as well as algorithms allowing to treat this information (machine learning, IA, optimization ...). It is a technological tool that allows reinforcing the performance of the object it represents, anticipating its evolution throughout its life cycle, planing production or maintenance activities, making the design evolve... in a framework constrained by objectives of economic, social, environmental performances.

Quarter number
ST4

Prerequisites (in terms of CS courses)
Continuum mechanics; Programming with Matlab or Python.

Syllabus
This course of introduction to the digital twin focuses on objects from the construction sector (building, bridge ...) or transportation sector (vehicle). Aspects related to information on the geometry, the behavior of the system (mechanical for example), and external dynamic actions (wind, pedestrians, waves ...) will be presented. Methods will be presented for inferring optimal parameters for the object model using data collected during its life.
The course will highlight the fact that these sources of information contained in the digital twin are treated by different disciplinary fields of expertise and different professions (architect or designer, structural engineer, fluid mechanic ...) which each rely on specific tools, methods and practices.

Class components (lecture, labs, etc.)
The course is divided into 11 sessions of 3 hours of lectures or tuturials, then a final session of 1.5 hours for the evaluation of the skills acquired:

- 4 sessions (with Rhino / Grasshopper software) dedicated to computational parametric design.
- 5 sessions (lecture + hands-on with Pythagore software, numerical modeling of structures) dedicated to modeling structural engineering structures.
- 1 session (lecture + hands-on with Python) dedicated to the numerical simulation of environmental dynamic actions.
- 1 session (lecture + hands-on Python) dedicated to Bayesian approaches for inferring parameters.

Grading
1.5h exam (50%)
1.5h computational design individual project

Course support, bibliography
Bibliographical lists and documents with methodological notes will be provided during the course.

Resources
Teachers: Pierre-Étienne Gautier, Pierre Jehel, lecturers

- Classrooms for hands-on sessions : 35 students
- Software : Rhinoceros3D / Grasshopper, Pythagore

Learning outcomes covered on the course
With this course, students will gain capabilities for:

1. generating and developing the digital twin of a simple physical object from the sectors of transportation or construction (geometry, behavior, and external actions modeling in a holistic perspective).
2. managing the information contained in a digital twin throughout the life cycle of the physical object it represents.
3. understanding the specificities of different actors that interact with the digital twin.
4. gathering various skills for the benefit of the global performance of the represented object.

Description of the skills acquired at the end of the course
C4 – Having a sense of value creation for your company and its customers
C6 – Being operational, responsible, and innovative in the digital world
C7 – Knowing how to convince
C8 – Leading a project, a team