Master's Department of Engineering Sciences

Name of the unit: Simulation of mechanisms

Lecturer: Sinan Haliyo (sinan.haliyo@sorbonne-universite.fr)
Course code: UM4RBR14
Student workload: 12h of lectures, h of tutorial sessions, 16h of lab sessions@
Credits: 3 ECTS

Specialization tracks:	- **E3A** :	☐ CIMES	☐ Syscom	☐ IPS
	- **AR** :	☒ ROBOT	☐ SI	☐ MeDH
	- **MECA** :	☐ MS2	☐ MF2A	☐ CompMech
		☐ ACOU	☐ EE	☐ EE APP

Semester offered: ☒ S1 ☐ S2 ☐ S3 ☐ S4
Language of instruction: ☒ French ☐ English
Targeted audience: ☒ Engineering Sciences students ☐ Other (specify):
Localization : ☒ PMC Campus ☐ Other (specify):

Course Overview

The aim of this course is to teach numerical simulation techniques for mechanical systems, for use in a robotic setting. In particular, we will see the methods of numerical resolution of equations of motion through temporal discretization techniques. In particular, ordinary differential equations will be studied using different integration techniques. These tools will be implemented to design the software architecture of an interactive simulation infrastructure using object programming approaches. From the modeling of a mechanical system, we will learn how to achieve its software implementation for interactive real-time use, capable of reproducing its behavior in a realistic way. This infrastructure will serve as a support for modeling simple robotic systems and synthesizing controllers.
Keywords: Mechanical modeling, dynamic interactive simulation, software architecture, object programming, graphical visualization, user interface

Prerequisites

Students should have previously acquired the following prerequisites to follow this course:

- Programming base (python, objects)
- Mechanical Modeling
- Numerical methods

Intended Learning Outcomes

By the end of this course, students will be able to:

1. Solving an EDO by discretization
2. Design a software architecture for simulation
3. Numerical implementation of mechanical models of robotic systems
4. Programming of interactive event-based resolution loops
5. Interpreting simulated behaviors of mechanical systems
6. Synthesis, implementation, and validation of simple controllers

Indicative Teaching Sequence and Methods

Week	C/TD/TP*	Content	Preparation	Learn. outc.
S1	4H C	Generality, reminder of numerical methods, mechanical modeling of robotic systems		
S2	2H C + 2H TP	Implementation of mathematical tools in software objects		
S3	2H C + 2H TP	Software architecture of a simulator		
S4	2H C + 2H TP	Interactive real-time simulation		
S5	2H C + 2H TP	Synthesis of controllers on simulation		
S6	4H TP	Validation on simple systems		
S7	4H TP	Implementation of a servo-controlled inverse pendulum		
S8	4H Project	Project		
S9	4H Project	Project		

* C/TD/TP respectively corresponds to lectures, tutorials and lab sessions.

Indicative Assessment of Intended Learning Outcomes (1st session)

Week	Individ./group	In-person/remote	Type of exam	Evaluated outcomes	Scale %
S8	Individual	In-person	Written	All	40 %
S10	Individual	In-person	Practical	All	60 %

2nde session of exam

Session	Individ./group	In-person/remote	Type of exam	Evaluated outcomes	Scale %
2	Individual	In-person	Other	All	100 %

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