Fakultät für Ingenieurwesen
Facoltà di Ingegneria
Faculty of Engineering

COURSE DESCRIPTION – ACADEMIC YEAR 2023/2024

Course title	**Modeling and Simulation of Multibody Systems with Multiphysics Coupling**
Course code	
Scientific sector	ING-IND/13 + ING-IND/14
Degree	PhD in Advanced Systems Engineering
Semester	2
Year	2023-2024
Credits	3
Modular	

Total lecturing hours	*30*
Attendance	Attendance to the lectures is highly recommended. Non-attending students have to contact the lecturer at the start of the course to agree on the modalities of the independent study. For the hands-on sessions and case-study/project activities, attendance is compulsory.
Prerequisites	
Specific educational objectives	This course aims at touching fundamental and advanced concepts on the: A. modeling and simulation of complex articulated mechanical systems, denoted as multibody systems, such as vehicles, robots, mechanical transmissions, etc., also featuring a multi-physics coupling. B. various modelling approaches available to simulate multi-physical engineering systems. Interactions between solids and between solids & fluids will be covered both from a theoretical and from a practical point of view. Hands-on sessions will allow students to implement and evaluate case-studies and examples.

Lecturer(s)	*Renato Vidoni* *https://www.unibz.it/it/faculties/engineering/academic-staff/person/31254-renato-vidoni* *Franco Concli* *https://www.unibz.it/it/faculties/engineering/academic-staff/person/34279-franco-concli*
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Scientific sector of lecturer(s)	ING-IND/13 ING-IND/14
Teaching language	English
Office hours	*Arrange beforehand by email.*
Lecturing Assistant (if any)	
Contact LA	

List of topics	This course is subdivided into two modules aimed at touching fundamental and advanced concepts on the: a) Modeling and simulation of complex multibody systems (MBS). b) Approaches available to simulate multi-physical engineering systems. Topics: a) Introduction and reference kinematics for MBS; analytical techniques; equations of motion; mechanics of deformable bodies (small and large deformations); Floating Frame of Reference formulation or Equivalent Rigid Link System formulation; hints on Model Order Reduction. b) Grid-based (Finite Volumes - FV - and Finite Elements – FE) and meshless (Smooth Particle Hydrodynamics - SPH) modelling approaches; strong and weak couplings between different physics (mesh-based approaches – i.e FV & FV and FV & FE). SPH theory and application. During the hands-on sessions, open-source software (e.g. Python, OpenFOAM®, Calculix, DualSPHysics) or commercial software (e.g. Adams MSC or Matlab) will be uses.
Teaching format	Frontal lectures, exercises, project(s).

Learning outcomes	By the end of the course, students should be able to: <u>Knowledge and understanding</u> D1.1) Know the theoretical bases of the available numerical simulations techniques for the solution of engineering problems (M1 & M2). <u>Applying knowledge and understanding</u> D2.1) Know how to apply modelling techniques for multibody systems (M1). D2.2) Know how to apply numerical approaches to practical design cases of multiphysical environments (M2). <u>Making judgements</u> D3.1) Critically analyze the results of the simulations, discuss their accuracy, on the basis of the modelling approach (M1 & M2). D3.2) Define the best modelling approach with a tradeoff between the accuracy and the computational effort (M1 & M2). <u>Communication skills</u> D4.1) Prepare a technical report/paper and a presentation describing the selected topic/ application where the methods, developed activity and choices are presented and discussed (M1 & M2). <u>Learning skills</u> D5.1) Ability to autonomously extend the knowledge acquired (M1 & M2).

Assessment	Formative assessment Form / Length /duration / ILOs assessed In class exercises / 8 X 120 minutes / 2, 3, 4 Summative assessment Form / % / ILOs assessed Report and presentation* / 100 / 2,3,4,5
Assessment language	English
Assessment Typology	
Evaluation criteria and criteria for awarding marks	Quality of the technical report (40%), correctness of the results (30%) Presentation (30%)

Required readings	Lecture notes and documents for exercise will be available on OLE.
Supplementary readings	Further material will be possibly provided by the lecturers
Software used	Python, OpenFOAM®, Calculix, DualSPHysics, Adams MSC and/or Matlab, PrePoMax