COURSE DETAILS

"DIGITAL MODELLING OF INTERACTIVE SYSTEMS AND INTERFACES"

SSD ING-IND/15

DEGREE PROGRAMME: AUTONOMOUS VEHICLE ENGINEERING (MOVE)

ACADEMIC YEAR 2022-2023

GENERAL INFORMATION – TEACHER REFERENCES

TEACHERS: STANISLAO PATALANO, GIUSEPPE DI GIRONIMO
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GENERAL INFORMATION ABOUT THE COURSE

YEAR OF THE DEGREE PROGRAMME: I
SEMESTER: I
CFU: 6

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE "REGOLAMENTO")

none

PREREQUISITES (IF APPLICABLE)

Basic knowledge of mechanics; basic knowledge of the MATLAB/Simulink environment.

LEARNING GOALS

The course aims at providing students with tools and methods for the designing of interactive systems and interfaces by using multidomain modeling, simulations, and virtual prototyping. At the end of the course, the student will be able to: develop 3D models of mechanical assemblies; choose appropriate graphics and technical communication tools for the design of mechanical systems; assign and evaluate characteristics and properties of mechanical systems in a virtual environment: shapes, proportions, materials, tolerances, appearance; manage reference protocols for data exchange; execute finite element structural analysis (FEM) in virtual environment on mechanical parts and assemblies; use VR/AR and human modeling technologies for the analysis and validation of industrial products; develop multidomain models and simulations using MATLAB Simscape environment; simulate behavior of electro-mechanical systems.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

The course aims to provide students with knowledge related to methodological tools aimed to the design and development of interactive systems and interfaces using digital modelling techniques. The student must demonstrate that he/she is able to manage CAD-CAE models in a PLM platform. The student will also have to demonstrate the knowledge of the main design phases for a mechanical system, from requirements elicitation to the construction of the virtual prototype and its validation using simulation tools.

Applying knowledge and understanding

The student needs to show ability to build virtual prototypes using specific software for product life cycle management, geometric modeling, structural analysis and ergonomic validation, , multidomain modeling and simulations, kinematic simulation of digital models. The student needs to show ability to develop a conceptual project of an interactive system and its interfaces in a virtual environment, identifying normalized elements and parts to be designed, managing the reference protocols for data exchange, and evaluating the simulation systems suitable for the development and validation of the project.

COURSE CONTENT/SYLLABUS

Introduction to the course: objectives, contents, examination methods. Geometry Based Modeling: 2D Drafting, 3D Wireframe Modeling, Modeling Primitives, B-Rep, CSG, Hybrid. Knowledge-Based Modeling. Parametric and Variational Approach, Feature-Based Solid Modeling. Parametric-associative paradigm. Product structure: parts, components, assemblies. Part modeling. Tools for managing sketch-based features. Constraint Management. Sketch analysis tools. Tools for creating and managing advanced features: Detailing features, Transformation features, Boolean features. CAD tools for the creation, analysis, and manipulation of surfaces. Data exchange problems. Generation of drawings and product documentation starting from CAD models. The bill of materials (2CFU).

Generative Structural Analysis and Finite Element Method (FEM); preprocessing: creation of the mesh, constraint conditions, application of loads; post-processing: evaluation of the stress state, displacements, and deformations. Digital Human modeling: conventional and task oriented anthropometric measurements; kinematic models; assignment of human tasks; performance evaluation methods; force and torque analysis; postural evaluation indices. Virtual Reality in industrial engineering design: stereoscopic vision, visualization systems, tracking systems, navigation systems, manipulation systems, haptic systems. Processing of geometric

models for virtual prototyping: tessellation, Rendering and Texture mapping. Applications in the railway, automotive, aeronautical and energy sectors. Augmented and Mixed Reality (2CFU).
Multidomain modeling principles. Definition of generalized variable in complex systems. Power and energy variables in different domains. Bond-Graph representation. Elements of a bond-graph. Computational causality. Energy storage elements. Resistors and Sources. Transformers and Gyrators. Basic rules for building and analyzing power transmissions. Object oriented mathematical modelling. Classes and instances. Inheritance. Equations. Physical Network Approach to Modeling. Acausal physical modelling. Component model. Library development and use. Multi-body modelling. Model Simulation in MATLAB Simscape environment. Multiobjective optimization (2 CFU).

READINGS/BIBLIOGRAPHY

Gary R. Bertoline, Eric N. Wiebe, Fundamentals of Graphics Communication, McGraw Hill, 2003
Mortenson M.E., Geometric Modeling, Ed. John Wiley & Sons, 1997
Caputo F., Di Gironimo G., La Realtà Virtuale nella Progettazione Industriale, Aracne, 2007.
Das S., Modeling and Simulation of Mechatronic Systems using Simscape (2020). Synthesis Lectures on Mechanical Engineering, Morgan & Claypool Publishers, ISBN: 9781681737355.
MATLAB suite available for UNINA students.
Exercise tables (teachers' websites); Slides and supplementary handouts provided by the teachers (teachers' websites).

TEACHING METHODS

The teaching activities will be organized as follows:

a) Lectures and practical exercises in the classroom dedicated to ***Digital Modelling*** and based on Dassault Systemes PLM tools (CATIA V5 for 3D CAD modeling, FEM analysis; Siemens Tecnomatix Jack for Ergonomics analyses) for about 33% of the total hours.
b) Lectures and practical exercises in the classroom dedicated to ***Virtual Prototyping*** and based on Dassault Systemes PLM tools (Siemens Tecnomatix Jack for Ergonomics analyses) for about 33% of the total hours.
c) Lectures and practical exercises in the classroom dedicated to ***Multidomain Modelling and Simulations*** and based on software MATLAB Simulink/Simscape for about 33% of the total hours.

EXAMINATION/EVALUATION CRITERIA

a) Exam type:

Exam type	
written and oral	
only written	
only oral	X
project discussion	X
other	

b) Evaluation pattern:

The oral exam is focused on the presentation of a project. Moreover, during the oral exam, the aim is also to assess the knowledge of all the concepts and contents given during the course lectures.