Faculty	**Ingegneria**
Master	**Mechatronic Engineering (La Spezia)**
Year/Semester	**1/I and II**

Course Title	**Kinematics, dynamics and design of mechanical systems**
ID Course Code	**56557**
Course Credits (CFU)	**12**
Scientific-Disciplinary Sector	**ING-IND/13**
Course Type	**mono-disciplinary course**
Lecturer-in-charge	**BRUZZONE Luca; FANGHELLA Pietro**

Learning Outcomes:

The course aims to provide operative engineering knowledge about: functional features, kinematics and inverse dynamics of mechanisms and advanced transmission gears; vibrating systems; dynamics of mechanisms with variable transmission ratio; mechanical non-linearity (backlash, fiction, saturation); integration with drives and control systems; practical use of kinematic and dynamic models for the design of mechanical and mechatronic systems; software tools for the simulation of mechanical and mechatronic systems.

Course Organisation Details

Mobility and structure of mechanical systems: bodies and joints in 2D and 3D; evaluation of the number of d.o.f.; exceptions, examples.
Kinematics: kinematics of the rigid body in 2D; relative motion; Coriolis acceleration; position, velocity, acceleration equations (examples); kinematics of the rigid body in 3D (position and orientation, Euler angles, homogeneous transforms, equivalent angle/axis, angular acceleration and speed); angles of force transmission and motion quality; mechanical gain; singularities.
Vibration of linear systems with multiple d.o.f.: theory of eigenvectors/eigenvalues; modal analysis; mode shapes; free and forced response; examples; Matlab/Control System Toolbox examples; rotor vibrations.
Mechanical transmissions: motoreducers; epicyclical gearboxes, harmonic drives, cyclo drives; examples and exercises.
Motion laws: types and characteristics; cams and their shapes; frequency behaviour; design examples for given motion requirements.
Dynamics: mechanical models; choice of state variables; dynamics equations (theory and examples with cardinal equations and virtual work principle); interactions motor/load/transmission; modelling of non-linear phenomena (friction, backlash, saturation, collisions); integration with control systems; exercises with Matlab/Simulink.
Multibody systems: theory of multibody systems; examples; introduction to Matlab/SimMechanics; exercitations with Matlab/SimMechanics.

Assessment	hours
Lectures	**80.0**
Practice	**25.0**
Laboratory	**15.0**
Integrative activities	**0.0**

References

- V. Cossalter, Meccanica applicata alle macchine, Ed. Progetto, Padova
- Course slides

Organization and examinations

The examination is composed of the carrying out and the discussion of an applicative design and, moreover, of two/three questions about the themes of the course.

Pre-requisites

No pre-required course.