UNICUSANO
ROME

Code: ING-IND/13 **Credits: 6**
Course: Applied Mechanics and Automation
Main language of instruction: Italian
Other language of instruction: English

Teaching Staff

Head instructor
Prof. Danilo GUARINO - danilo.guarino@unicusano.it

Introduction

1. *Objective of the course :*

The course of mechanics and automation aims to make acquire to students a good knowledge of mechanics and industrial automation. The course proposes the basic concepts of kinematics, declining them in the study of mechanisms, and dynamics. It also describes the automation processes and robotic systems involved in such processes. In addition, the educational objective of the course is to provide to the students a knowledge on the operation of devices both mechanical, such as flat articulated systems and transmission joints, and both robotic, such as planar open-chain manipulators. The Etivities associated to the course develop the skills necessary to formulate the problems of mechanics, automation and robotics.

Objectives

2. *Course Structure:*

- Kinematics reminders
- Planar mechanisms
- Automatic fundamentals
- Feedback systems
- Robotic systems
- Automation

Competencies:

A. Knowledge and understanding:

The students, at the end of the course, will have knowledge of the laws of kinematics and dynamics of mechanical systems, and will have acquired the ability to formulate mathematically, the kinematics and dynamics of the same. It will also have the knowledge of industrial automation systems, computer integrated manufacturing, hardware architectures for control and development of an automation systems. The student will acquire the knowledge of the functioning of the main machine parts, such as planar articulated systems and transmission couplings, of the main actuation systems, such as electric and hydraulic servomotors, and the main transduction systems, such as encoders and accelerometers.

B. Applying knowledge and understanding:

The student will be able to use the knowledge of kinematics and dynamics mechanical systems for the analysis of the same; they will also be able to use knowledge of automation processes systems involved, in order to analyse these processes and systems for the general selection of components.

C. Making judgements:

The students will be able to identify the most appropriate mathematical models to describe the individual functional blocks of a mechanical system and of an industrial automation system; they will be able to interpret the specifications provided by manufacturers of mechanical and mechatronic devices, and choose from catalogs the most appropriate ones for the application or productive process.

D. Communication skills:

The students will be able to describe and sustain conversations on kinematics and dynamics problems of mechanical systems and problems concerning industrial automation systems; they will be able to correctly identify and describe the physical quantities and relevant components, using appropriate terminology.

E. Learning skills:

At the end of the course, the students will have knowledge of the fundamental notions necessary for the analysis of mechanical systems and industrial automation processes. All this will allow him to continue his engineering studies with greater maturity and will provide them with the basis to be able to learn what will be offered in the specialized courses of mechanics, with particular reference to the topics of "cold mechanics", automation and industrial robotics.

Syllabus

3. *Programme of the course:*

Subject 1 – Kinematics reminders
Lesson 1. Point kinematics.
Lesson 2. Rigid body kinematics.
Lesson 3. Kinematic constraints.
Lesson 4. Kinematic motion models.
Lesson 5. Kinematic: exercises.

Subject 2 – Planar mechanisms
Lesson 1. Kinematics of planar articulated systems.
Lesson 2. Kinematic analysis.
Lesson 3. Mechanisms – Insights and examples.
Lesson 4. Slider-crank mechanism.
Lesson 5. Fairbairn mechanism.
Lesson 6. Equations closure method: slider-crank mechanism.
Lesson 7. Equations closure method: articulated quadrilateral.
Lesson 8. Equations closure method: swinging glyph

Subject 3 – Automatic fundamentals
Lesson 1. Laplace transform.
Lesson 2. Dirac delta function.
Lesson 3. Laplace antitransformation.

Subject 4 – Feedback systems
Lesson 1. Types of automation system.
Lesson 2. Feedback system.
Lesson 3. Transfer function.

Subject 5 – Robotic systems
Lesson 1. The “robot” system.
Lesson 2. Homogeneous transformations.
Lesson 3. Denavit-Hartenberg method.
Lesson 4. Denavit-Hartenberg method: exercise.
Lesson 5. Denavit-Hartenberg method: examples of application.

Subject 6 – Automation

Lesson 1. Industrial automation: from the first mechanisms to industry 4.0
Lesson 2. Production processes.
Lesson 3. Production processes automation.
Lesson 4. Phases of development of an industrial automation system.

Evaluation system and criteria

The examination consists of a written test. This includes:

- 2 exercises (10 marks each for a total of 20 out of 30 marks).
- 3 open-ended theory questions (two 2,5 mark questions and one 2 marks question, for a total of 7 out of 30 marks).

In addition, three e-tivities, that need to be sent to the instructor in advance of the examination. Each e-tivity counts 1 mark for a total of 3 out of 30 marks.

Bibliography and resources

4. *Materials to consult*

Notes written by the instructor are available in Italian.

5. *Recommended bibliography*

Suggested readings are:

- Ettore Pennestrì, Augusto Di Benedetto: **Introduzione alla cinematica dei meccanismi (Vol. 1, Vol. 2, Vol. 3)**;
- Ettore Pennestrì, Nicola P. Belfiore, Augusto Di Benedetto: **Fondamenti di meccanica applicata alle macchine**;
- C.Ferraresie, T.Raparelli: **Meccanica Applicata. Terza edizione. Torino CLUT,2007**;
- A.Isidori: **Sistemi di controllo. Seconda edizione (Volume 1), 1992**;
- B. Siciliano, L. Sciavicco, L. Villani, G.Oriolo: **Robotica. Modellistica, pianificazione e controllo. Mcgraw-Hill, 2008**;
- C. Bonivento, L. Gentili, A. Paoli: **Sistemi di automazione industriale, Mcgraw-Hill, 2011**