COURSE DESCRIPTION
FOUNDATIONS OF ROBOTICS

SSD: AUTOMATICA (ING-INF/04)

DEGREE PROGRAMME: INGEGNERIA DELL'AUTOMAZIONE E ROBOTICA (P38)
ACADEMIC YEAR 2022/2023

COURSE DESCRIPTION

TEACHER: SICILIANO BRUNO
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GENERAL INFORMATION ABOUT THE COURSE

INTEGRATED COURSE: NOT APPLICABLE
MODULE: NOT APPLICABLE
CHANNEL: FG A-Z
YEAR OF THE DEGREE PROGRAMME: I
PERIOD IN WHICH THE COURSE IS DELIVERED: SEMESTER II
CFU: 9

REQUIRED PRELIMINARY COURSES

None.

PREREQUISITES

Basic knowledge of: linear algebra, modeling of mechanical and electrical systems, closed loop control systems

LEARNING GOALS

The course aims to provide the basic skills for modeling, planning and motion control of robots.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

The course path aims to provide students with the methodological tools for modeling, planning and control of robots. Robot components, kinematic, static and dynamic models of manipulating robots, trajectory planning techniques and control schemes are introduced. The student must demonstrate that (s)he has learned the requirements of the systems dedicated to the control of

robots, on the basis of the models used. The student will also have to demonstrate knowledge in the derivation of models and in the validation of algorithms for kinematic inversion and control using simulation tools.

Applying knowledge and understanding

The student must demonstrate to be able to derive kinematic, static and dynamic models and know how to apply them to practical case studies concerning open-chain robot manipulators. Starting from these, (s)he must demonstrate that (s)he is able to design control schemes that solve the regulation and trajectory tracking problems and know how to validate them in the Matlab / Simulink® environment.

COURSE CONTENT/SYLLABUS

Industrial robotics and advanced robotics
Description and principles of operation of a robot
Direct kinematics
Kinematic calibration
Differential kinematics and Jacobian
Redundancy and singularities
Inverse kinematics algorithms
Kineto-statics duality
Planning of trajectories in the joint space and in the task space
Actuators and sensors
Control unit
Lagrangian model
Remarkable properties of the dynamic model
Newton-Euler recursive algorithm
Identification of dynamic parameters
Direct dynamics and inverse dynamics
Decentralized control
Independent joint control
Centralized control
Computed torque control
PD control with gravity compensation
Inverse dynamics control
Robust and adaptive control
Task space control

READINGS/BIBLIOGRAPHY

B. Siciliano, L. Sciavicco, L. Villani, G. Oriolo, Robotics –Modelling, Planning and Control, Springer, London, UK, 2009, DOI: 10.1007/978-1-84628-642-1

Italian translation: Robotica –Modellistica, Pianificazione e Controllo, McGraw-Hill Libri Italia, Milano, I, 2008
B. Siciliano, Robotics Foundations I, MOOC available on the platform www.federica.eu
B. Siciliano, Robotics Foundations II, MOOC available on the platform www.federica.eu
Lecture notes available at https://prisma.dieti.unina.it/index.php/education/education-courses/34-robots-foundations

TEACHING METHODS OF THE COURSE (OR MODULE)

The teacher will use: a) frontal lessons for about 70% of the total hours, b) classroom exercises for about 30% of the total hours.

EXAMINATION/EVALUATION CRITERIA

a) Exam type

- ☐ Written
- ☑ Oral
- ☑ Project discussion
- ☑ Other : Students are admitted to the oral exam after carrying out a design project in Matlab/Simulink® concerning the simulation of inverse kinematics algorithms and control systems for robot manipulators. The exam consists of a critical discussion of the paper and in ascertaining the acquisition of the concepts and contents introduced during the lessons.

In case of a written exam, questions refer to

- ☐ Multiple choice answers
- ☐ Open answers
- ☐ Numerical exercises

b) Evaluation pattern

The development of the project is binding for the purposes of accessing the oral exam. The project and the oral exam each contribute 50% of the final evaluation and, therefore, the development of the project is not sufficient to pass the exam.