Course guide
2400181 - 240MEI34 - Fundamentals of Robotics

Last modified: 16/04/2026

Unit in charge: Barcelona School of Industrial Engineering
Teaching unit: 707 - ESAII - Department of Automatic Control.

Degree: MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2025). (Optional subject).

Academic year: 2026 **ECTS Credits:** 5.0 **Languages:** Catalan

LECTURER

Coordinating lecturer: Rosell Gratacos, Joan

Others: Rosell Gratacos, Joan
Bolea Monte, Yolanda

TEACHING METHODOLOGY

The course combines theoretical lectures, computer-based practical sessions, and hands-on laboratory work with robots. Lectures cover fundamental concepts, practical sessions focus on MATLAB-based exercises to deepen the understanding of the theory, and laboratory work provides experience with real robots to apply and validate the concepts learned in practice.

LEARNING OBJECTIVES OF THE SUBJECT

General objective
To provide students with the fundamental concepts and tools required to model, analyze, and program robotic manipulators, integrating kinematics, dynamics, control, and practical implementation.

Specific objectives:
1. Understand and model robotic systems, including kinematics (forward, inverse, and differential) and trajectory planning.
2. Analyze the dynamics of robotic manipulators and apply basic control strategies.
3. Implement and validate robotic algorithms using MATLAB for simulation and analysis.
4. Acquire hands-on experience in programming industrial robots and integrating them with peripheral devices to solve manipulation tasks.

STUDY LOAD

Type	Hours	Percentage
Hours small group	15,0	12.00
Hours large group	30,0	24.00
Self study	80,0	64.00

Total learning time: 125 h

CONTENTS

Introduction

Description:
1.1 Origins and evolution of robotics
1.2 Definition and classification of robots
1.3 Applications of robotics
1.4 Architecture of a robotic system

Specific objectives:
Students will understand the origins, evolution, and main application areas of robotics. They will also be able to identify and describe the basic architecture and classification of robotic systems.

Full-or-part-time: 3h
Theory classes: 1h 30m
Practical classes: 1h 30m

Kinematics

Description:
2.1 Rigid bodies and homogeneous transformations
2.2 Modeling of robotic manipulators
2.3 Forward kinematics
2.4 Geometric Jacobian / Analytical Jacobian
2.5 Inverse kinematics
2.6 Singularities and redundancy
2.7 Trajectory planning

Specific objectives:
Students will understand and model the kinematics of robotic manipulators, including forward, inverse, and differential kinematics. They will also be able to analyze singularities, redundancy, and plan trajectories for robotic motion.

Related activities:
MATLAB exercises in the computer classroom

Full-or-part-time: 15h
Theory classes: 7h 30m
Practical classes: 7h 30m

Dynamics, control and programming

Description:
3.1 Lagrangian formulation
3.2 Dynamic model of manipulators
3.3 Control structures
3.4 Robot Operating System

Specific objectives:
Students will understand the dynamic modeling of robotic manipulators and the fundamental principles of control in robotic systems. They will also become familiar with robot programming frameworks such as the Robot Operating System (ROS).

Related activities:
MATLAB exercises in the computer classroom

Full-or-part-time: 12h
Theory classes: 6h
Practical classes: 6h

GRADING SYSTEM

Laboratory assignments: 20%; Problem deliverables: 20%; Final exam: 60%.
Resit: A resit exam will be scheduled for course recovery, with a weight of 80%, replacing the percentages of the final exam and the problem deliverables.

EXAMINATION RULES.

Laboratory sessions and the associated assignments must be carried out in groups of two students.

BIBLIOGRAPHY

Basic:
- Siciliano, Bruno; Villani, Luigi; Oriolo, Giuseppe; De Luca, Alessandro. Foundations of robotics [on line]. Switzerland: Springer, 2025 [Consultation: 30/07/2026]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-3-031-85523-8. ISBN 9783031855221.

Complementary:
- Siciliano, Bruno. Robotics : modelling, planning and control . London : Springer, cop. 2010. ISBN 9781849966344.