

Course guide

300102 - STCROB - Robot Predictive Maintenance

Last modified: 04/07/2026

Unit in charge: Castelldefels School of Telecommunications and Aerospace Engineering
Teaching unit: **Degree:** MASTER'S DEGREE IN ARTIFICIAL INTELLIGENCE FOR CONNECTED INDUSTRIES (AI4CI) (Syllabus 2025). (Optional subject).

Academic year: 2026 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: Javier Martín Oña (JM Robótica), Adrián Salazar (ITCL)

Others: Javier Martín Oña (JM Robótica), Adrián Salazar (ITCL)

PRIOR SKILLS

Basic Programming Knowledge: Many advanced robotics courses assume that students have solid programming knowledge. Electronics Fundamentals: Understanding basic electronics concepts such as resistance, voltage, current, and having experience with common electronic components could be essential for working with robotic hardware.

REQUIREMENTS

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TEACHING METHODOLOGY

Lectures, assignments, project

LEARNING OBJECTIVES OF THE SUBJECT

The goal of this STC is to teach you the basics of robotic typologies and operations, and how to perform and predict maintenance tasks on robots' main constituent elements. This knowledge will enable you to define and implement a preventive maintenance plan for a robot, based on empirical tests and the manufacturer's specifications. In this STC, you'll learn the fundamentals of identifying and visualizing anomalies and failures in data provided by robot components. You'll learn how to map these anomalies to failure conditions, enabling you to perform predictive maintenance to manage failures and avoid costly downtimes. The course includes learning about the electrical motor elements that comprise an articulated robot and understanding their operation and function. You'll study the basic elements required to process and understand data obtained from the robot's internals for predictive maintenance purposes. Additionally, you'll learn how to carry out error diagnosis based on the robot's operation log and how to prevent accidents during the maintenance of robotic equipment.

STUDY LOAD

Type	Hours	Percentage
Hours large group	27,0	36.00
Self study	48,0	64.00

Total learning time: 75 h

CONTENTS

Robot Predictive Maintenance

Description:

Core content:

Carry out maintenance tasks on its main constituent elements, in order to define a preventive maintenance plan with a robot according to the empirical test and the manufacturer's specifications. Know the main predictive maintenance tools]

1- Morphological Foundations in Robotics: Types of Robots, Movement Control Systems, and Approaches to Access Maintenance Information of Main Constituent Elements

This section introduces the principal types of robots, focusing on the components most susceptible to failure in Industry 4.0 environments. You will gain an overall understanding of how these robots can be controlled and accessed. We will discuss the differences between commercial-brand robotics and open-source robotics, exploring how each solution allows us to access and analyse maintenance data from the robot's main components.

2- Mathematical and Programming Fundamentals of Robotic Programming

This section covers the practical and mathematical fundamentals of robot programming and calibration. It will explore the main programming paradigms used in the industry, including those employed by companies like ABB and open-source robotics platforms such as ROS. This section will include multiple references to the practical components of the modules.

3- Basic Robotic Sensors: Definition, Calibration, Potential Problems, and Maintenance

Sensors are a fundamental part of any robotic platform; most robots would not be able to operate without them. In this session, we will cover the foundations of the most important robotic sensors, how to calibrate them, the main problems that can occur with these devices and how to fix them, and good practices. The covered sensors are 2D cameras, 3D cameras, LIDAR, IMU, Radar, and wheel/motor encoders. We will also cover some use cases of these sensors to gain a deeper understanding of their use and discuss real situations where they failed and the problems such failures led to.

4- Preventive and Predictive Maintenance: Tools to Forecast Incidents and Create Maintenance Programs (Part 1)

In this section, we will cover the basics of data analytics using methods like regression, time series analysis, and anomaly detection to predict potential failures in robot components. We will utilize data provided by the log systems of robots, both commercial and open source. In addition, we will cover basic visualization tools that can help us better understand failures occurring in the main components of a robot.

5- Preventive and Predictive Maintenance: Tools to Forecast Incidents and Create Maintenance Programs (Part 2)

Supervised Lab:

The supervised lab will cover, from a practical perspective, the basics of 2D and 3D computer vision necessary to instruct a robotic arm on how to move to perform certain tasks. For example, to press a button with the arm, you first need to detect where the object you want to reach is in the world. Once we know where the object is, we can cover the principles of hand-eye calibration. The lab will use a simulation environment and Python as the main platforms. In the theory part, the student learned how to move a robotic arm in a given environment. The lab complements this with computer vision so the student will have the basic knowledge to participate in projects that require smart manipulation of objects.

Basics of 2D Computer Vision:

Types of 2D representations and how to process them (2 hours) (Python)

Detecting objects by shape and colour: feature extraction techniques and pixel clustering (4 hours) (Python)

Exercise to detect objects in 2D images in given industrial scenarios using the acquired knowledge.

Notion of advanced computer vision: basic theory and interesting cases (1-hour class)

Basic Principles of 3D Computer Vision:

Basic types of 3D data and which sensors to use to obtain them (2 hours) (Python)

Approaches to process 3D data: depth, colour, shape, and orientation (2 hours) (Python)

Exercise to detect objects in 3D images in given industrial scenarios using the acquired knowledge. Prepare a presentation explaining the approach (homework)



Basics of Control of Gazebo Simulator or Other Simulation Environment (2 hours)

Hand-Eye Calibration: Basics and Example (3 hours)

Complementary content:

Know the electrical-motor elements that comprise an articulated robot and understand its operation and function.

Know the control elements that direct and manage a robot, understand its operation and learn the basic notions of operation.

Learn to carry out an error diagnosis based on the robot's operation log.

Acquire the necessary knowledge to prevent accidents during the maintenance of robotic equipment.

Electronic composition of an articulated robot, access and maintenance of main constituent elements.

Introduction to communication and control systems. Hierarchies and dependencies with peripheral systems.

Security systems and devices in automated facilities.

Adjustment and parameterization operations. PID control

Verification and quality control of the operation.

Full-or-part-time: 75h

Theory classes: 27h

Self study : 48h

GRADING SYSTEM

A project assignment to perform after the course.