The Construct

MASTERCLASS
BROCHURE

# Robotics Developer

Learn to develop
intelligent robots from zero

| STARTS ON | DURATION | FORMAT |
| --- | --- | --- |
| February 7, 2022 | 6+1 Months / / Full Time<br>or<br>12 Months / / Part-Time | Online |

theconstructsim.com/**robotics-developer/**

# Overview

Robotics Developer Master Class is a bootcamp designed to help you master robotics development from zero to advanced, and get you fully prepared to work at any robotics company.

This program cover all the skills for 99% of robotics development (RobDev) jobs. To begin, you'll learn the basic and core concepts of robotics programming. Then you will strengthen your robotics programming skills by practicing key concepts such as transforms, robot definition files, or Gazebo 3D robot simulations. You will also to learn robotics theory to strengthen your foundation. Then you will learn to use and apply the most important tools and procedures for developing robotics projects. Finally, you will be able to use your newly acquired skills to put all your skills and knowledge to design, develop and present, a robotics app from scratch, and get fully prepared to work as a real robotics developer.

FUTURE-READY

# Kickstart Your Career in RobDev

### No Experience Necessary

Learn job-ready skills from zero. No previous degree or knowledge is required.

### 100% Practical

NO videos. NO slides. Learn by DOING with simulated and real robots.

### 100% Online

You can complete this program fully online. No setup is required.

### 1-on-1 Personal Mentor

Mentors with an average of 7 years of experience in the robotics field provide 1-on-1 coaching to guide you and answer all your questions.

# Program Schedule

## PHASE 1: BASICS PROGRAMMING & ROS

Learn the basic and core concepts of robotics programming. This phase includes autonomous robot navigation, sensing and perception, and robot manipulation. These skills are the foundation for any robotics project.
**Project**: Combine Manipulation, Perception, and Navigation to create a whole Pick & Place task with real warehouse collaborative robots.

- Assignment 1: Create a ROS Action that, when called, will make the robot move towards the recollect point (a place in the room) using data from the sensors (laser, odometry)
- Assignment 2: Create a service that receives a string as a request (the string will contain a name of a place). Then, the program sends a goal to the Navigation Stack to navigate there
- Assignment 3: Create a pick & place script that connects with MoveIt to pick an object from a place and place it in a different location. The pick and place positions will be hardcoded
- Assignment 4: Create a Perception node that gets the position of the object to pick
- Assignment 5: Create a main program that connects the Navigation with the Manipulation & Perception parts

| | WHAT YOU WILL LEARN | |
|---|---|---|
| **PREREQUISITES COURSE 1** | **Linux for Robotics** | • How to navigate through a Linux filesystem<br>• How to interact with a Linux filesystem<br>• How to edit files using the Shell (via editor)<br>• Manage access to files (Permissions)<br>• Create simple Linux programs (Bash Scripts)<br>• Manage execution of Linux programs (Processes)<br>• How to connect to a computer's remote robot (ssh) |

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| **PREREQUISITES COURSE 2** | **Python3 for Robotics** | • How to store data in Variables<br>• How to operate with the data in the Variables<br>• How to change behavior based on Conditions<br>• How to create Functions that can be called from other places in the code<br>• How to encapsulate the code into Classes so you can have clean and robust code |
| **COURSE 1** | **ROS Basics (Python)** | • Understand ROS Topics: Publishers, Subscriber & Messages<br>• Manage ROS Services in a robot<br>• Use Python classes in ROS<br>• Manage ROS Actions in a robot<br>• How to Debug ROS programs<br>• Setup ROS workspaces on your local computer |
| **COURSE 2** | **ROS Navigation** | • Setup ROS Navigation Stack on a robot<br>• Build a map of the environment from zero<br>• Perform Robot Localization<br>• Autonomous Path Planning<br>• Understand Simultaneous Localization and Mapping (SLAM)<br>• Obstacle Avoidance |
| **COURSE 3** | **ROS Perception** | • Track objects by its color blobs<br>• Navigate following floor lines with only an RGB camera<br>• Face detection and tracking<br>• Face recognition<br>• People tracking through a 3D environment<br>• Recognize flat surfaces like tables where objects might be placed<br>• Recognize objects and track them in 3D space with PointCloudSensors<br>• Use Yolo for object recognition and tracking in 3D space |
| **COURSE 4** | **ROS Manipulation** | • Motion Planning using Graphical Interfaces (MoveIt) for a manipulator robot<br>• Perform Motion Planning programmatically<br>• Grasping: perform a basic pick & place task |

# PHASE 2: ADVANCED ROBOT PROGRAMMING

Boost your robotics programming skills by practicing key concepts such as transforms, robot definition files, or Gazebo 3D robot simulations. Also, learn the basics of the latest Robot Operating System (ROS2).

**Project**: Build a robotic arm simulation from zero and create a ROS2 program that can execute motions in the arm.

Assignment 1: Create the ROS Control system of a Manipulator robot (robot provided)

Assignment 2: Create the URDF file for a manipulator robot

Assignment 3: Create the simulation of a manipulator arm

Assignment 4: Create a C++ program that allows the manipulator arm to move through a series of waypoints

Assignment 5: Create a ROS2 Action that, given a goal (the goal contains a string), will execute a motion in the manipulator arm

| | WHAT YOU WILL LEARN | |
|---|---|---|
| COURSE 5 | **ROS Control** | • How to configure ROS controllers to work with your robot simulation<br>• How to create a custom controller<br>• How to configure the ROS controllers to work with a 6DOF manipulator robot<br>• How to create a hardware interface for your robot |
| COURSE 6 | **URDF** | • How to build a visual robot model with URDF<br>• Use URDF for Gazebo Simulator to spawn a robot<br>• How to add physical properties to a URDF Model (Collision, Frictions and more)<br>• How to use XACRO to clean up URDF files<br>• How to use URDF in a Gazebo-ROS ecosystem |

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| **COURSE 7** | **ROS TF** | • How to bisualize TFs<br>• How to publish and subscribe to TF data<br>• Understanding Transformations & Frames<br>• Understanding Robot State Publisher & Joint State Publisher<br>• Be comfortable with common TF command-line Tools (tf_echo, view_frame and more)<br>• Understand Static Transform Publisher |
| **COURSE 8** | **Gazebo Basics** | • Work with Gazebo and ROS<br>• Build a robot simulation<br>• Connect a Gazebo robot to ROS<br>• Build a Gazebo World<br>• Gazebo Plugins |
| **COURSE 9** | **Modern C++** | • Build Tools<br>• The STL Library<br>• C++ Classes<br>• Object-Oriented Programming<br>• Pointers and References<br>• Templates<br>• Concurrency<br>• Exception Handling |
| **COURSE 10** | **ROS2** | • Create ROS2 packages<br>• Management of the new Colcon universal building system.<br>• Topic publishers and subscribers in ROS2 C++<br>• New launch system based on python<br>• Service servers and client generation for ROS2<br>• How to use ROS1-Bridge to communicate between ROS1 and ROS2<br>• Use of Debugging tools in ROS2 |

## PHASE 3: BUILD YOUR ROBOTICS KNOWLEDGE

Strengthen your foundation by learning robotics theory. Understand the physics and mathematical principles behind any robotic system, from simple kinematics to advanced planning and control algorithms.

**Project**: Design and Develop, from zero, the navigation system for a wheeled mobile robot

Assignment 1: Define the kinematic model of a mobile robot

Assignment 2: Program a dynamic controller for a manipulator arm

Assignment 3: Program an IK solver for a manipulator arm

Assignment 4: Program a KF filter for localizing a mobile robot

Assignment 5: Design and program a Path Planning system for a mobile robot

| | WHAT YOU WILL LEARN | |
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| COURSE 11 | **Math / Probability** | • Linear Algebra (vectors and matrices)<br>• Calculus (functions, derivatives, and integrals)<br>• Probability (random variables and belief distributions) |
| COURSE 12 | **Mobile Robots Kinematics** | • Rigid-Body Motions<br>• Kinematics for Non-Holonomic Robots<br>• Kinematics for Holonomic Robots<br>• Kinematic Control |
| COURSE 13 | **Arm Kinematics** | • Manipulator robot configuration<br>• How to compute the Forward Kinematics of a manipulator robot<br>• How to compute the Inverse Kinematics of a manipulator robot |
| COURSE 14 | **Robot Dynamics and Control** | • How to solve the dynamics for the motion of rigid bodies in 3D space with the use of Newton's laws of motion<br>• How to model the dynamics of a simple robotic system and how to derive its equations of motion<br>• How to create a full state feedback controller to allow a robotic system to balance |
| COURSE 15 | **Kalman Filters** | • Different types of Kalman Filters and when to apply each one<br>• Bayesian Filters<br>• One-dimensional Kalman Filters<br>• Multivariate Kalman Filters<br>• Unscendent Kalman Filters<br>• Extended Kalman Filters<br>• Particle Filters |

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| COURSE 16 | **Path Planning** | • Dijkstra algorithm: apply it to the motion planning of a mobile robot<br>• A* search algorithm<br>• Rapidly-Exploring Random Tree (RRT) applied to the robotic path planning problem<br>• Artificial Potential Fields (APF) applied to the mobile robotic path planning problem |

## PHASE 4: DEVELOP ROBOTICS PROJECTS

Learn to use and apply the most important tools and procedures for developing robotics projects. You will learn how to apply continuous integration techniques in real-world scenarios, so you're better prepared to bear the day-to-day work of a robotics developer.

**Project**: Develop a ROS-based web application from zero that provides a graphical interface to command a robot.

Assignment 1: Create a Web Application that interacts with a robot

Assignment 2: Include the Web Application into your Git repositories

Assignment 3: Encapsulate the Web Application into a Docker containers system

Assignment 4: Automate several processes of your project using Jenkins

Assignment 5: Add different Tests to your Web Application project

| | WHAT YOU WILL LEARN | |
|---|---|---|
| COURSE 17 | **Web Programming (HTML, Javascript, CSS)** | • HTML - How to display text, images, links, and more in a webpage<br>• CSS - How to style your page and make it prettier<br>• JavaScript - Programming a webpage and interacting with servers<br>• ReactJS Object-Oriented Programming - Learning the basics of one of the most popular JS frameworks |

| | | |
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| COURSE 18 | **Continuous Integration (Git)** | • Git Basics<br>• Git Repositories<br>• Git Branches<br>• Git and GitHub for Team Collaboration<br>• Pull Requests |
| COURSE 19 | **Docker** | • Understand key Docker concepts<br>• Run ROS nodes on Docker containers<br>• Create your own Docker Images and share them with other people<br>• Run multiple containers using Docker Compose and Kubernetes<br>• Apply all that you have learned in a ROS project |
| COURSE 20 | **Jenkins** | • Jenkins Basics<br>• Jenkins Jobs<br>• How to manage Users and Security<br>• Jenkins Pipelines<br>• Source Code Management (SCM) Integration<br>• Test Integration<br>• Jenkins Command Line Interface (CLI) |
| COURSE 21 | **Unit Testing** | • How to create Python Unit Tests<br>• How to create ROS Unit Tests<br>• How to create ROS Integration Tests |

## PHASE 5: PROVE YOUR SKILLS

Put all your skills and knowledge to the test. Design, develop and present, from zero, a complete robotics project applying everything you have learned during the program. This will lay the cornerstone for your career as a robotics developer.

## PHASE 6: ONE MONTH INTERNSHIP (OPTIONAL)

The Robotics Developer Master Class offers you practical work in one of the world's leading robotics companies. You will learn from industry practitioners, and enhance your knowledge with relevant work assignments that can help you prepare for your future career as a real Robotics Developer.

# Robots Used

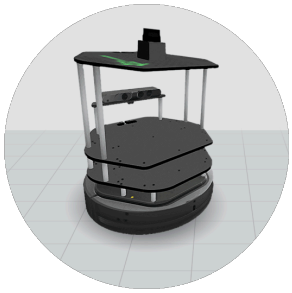
## SIMULATION ROBOTS

**BB-8**

**IRI Wam arm**

**Parrot A.R. Drone**

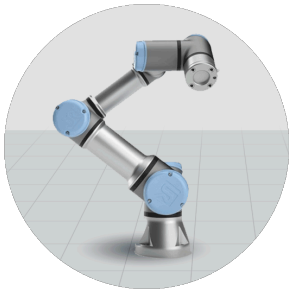
**TurtleBot2**



**SUMMIT-XL**

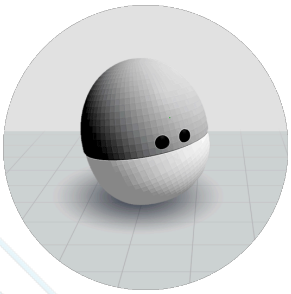
**Husky**

**UR3**

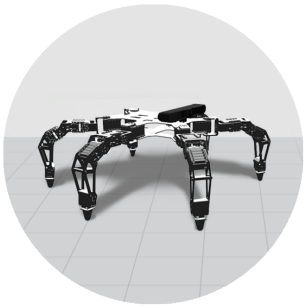


**Fetch**

**Mira**

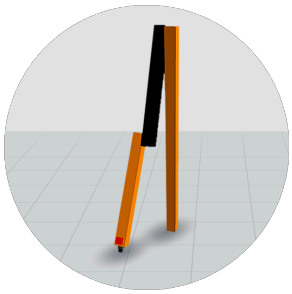


**Phantom X**



**RB-KAIROS**

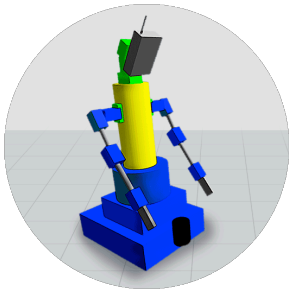
**RRBot**



**Neobotix MPO-500**

**3d Version of the Classical 2D TurtleSim**

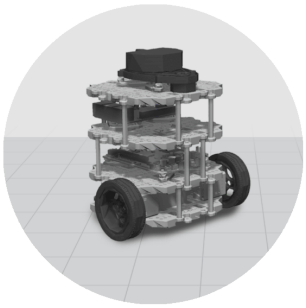
**Pi robot**



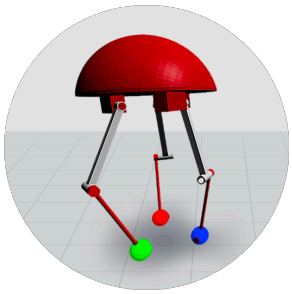
**ROSbot 2.0**

**Mara**

**TurtleBot 3**

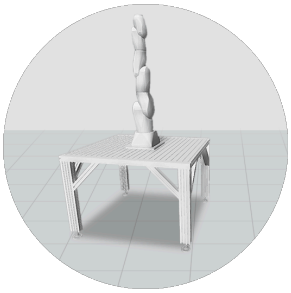


**Gurdy**

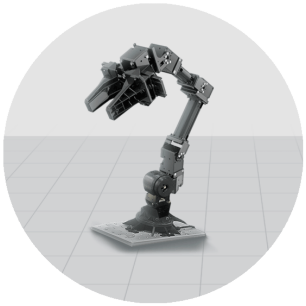


**JIBO**

**Motoman Sia10f simulation**

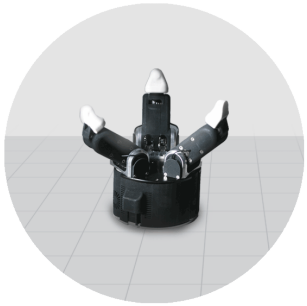


**Clarkson Open Manipulator**



**PR2**

**Shadow hand**



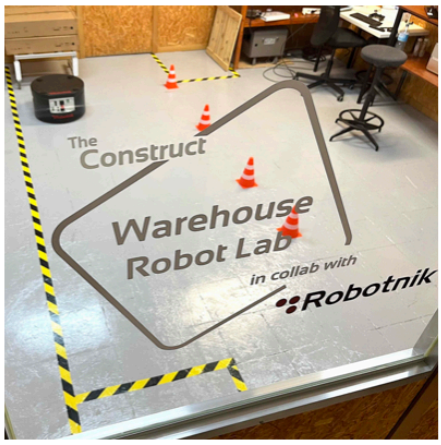
## REAL ROBOTS

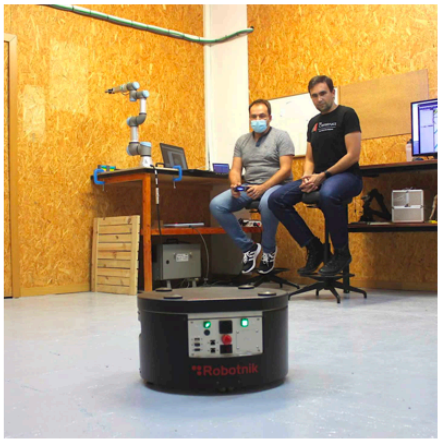
During the program, you will also learn robotics and develop robotic apps by connecting remotely to the following real robots to practice:

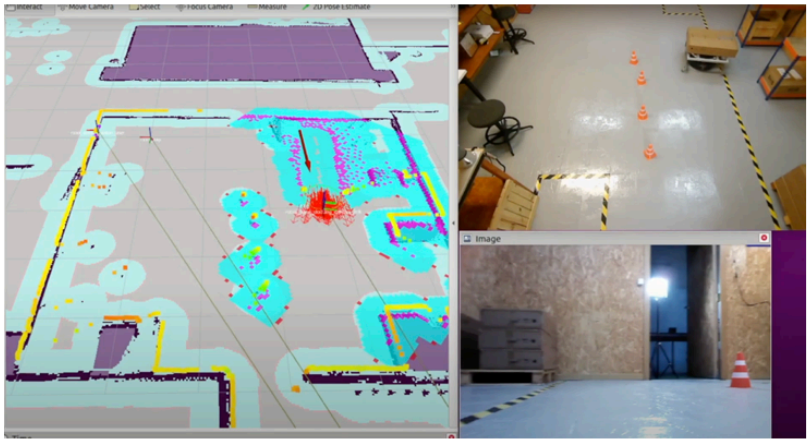
## RB-1 BASE mobile robot

This is a mobile base robot able to move shelves from one location to another. With this robot, practice autonomous navigation; carrying cargo from one place to another; and recognize environments, like tags, people, or objects.

See how it works (video).

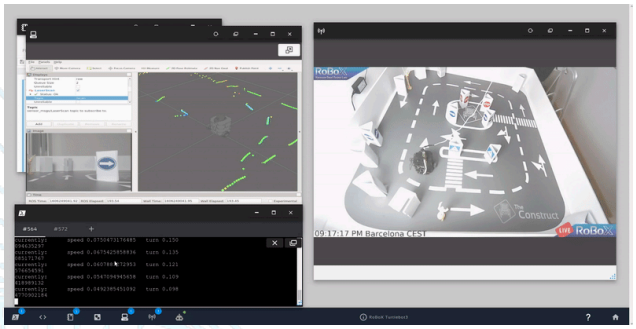



## UR3e robotic arm

This is a collaborative robotic arm with a gripper and a 3D sensor for perception. With this robot, you can practice manipulation, object detection, pick & place objects, and more.

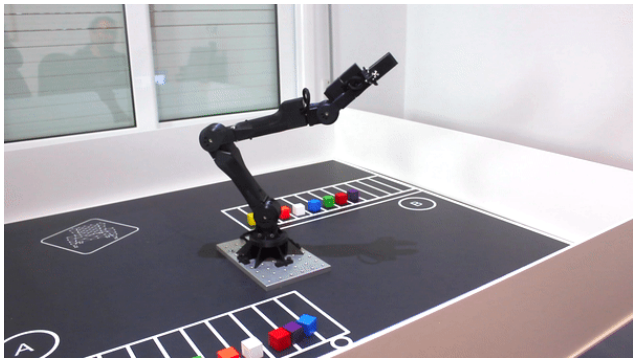
## TurtleBot3

This is a TurtleBot3 wheeled robot with lidar and camera.



## Manipulator

This is a 6DOF robotic manipulator with a 3D sensor.



## Certificate

Get recognized! Upon successful completion of this program, The Construct grants a certificate of completion to participants. This program is graded as a pass or fail; participants must prove their learning results in the final project to pass and obtain the certificate of completion.

After successfully completing the program, your verified digital certificate will be emailed to you with the name you used when registering for the program.

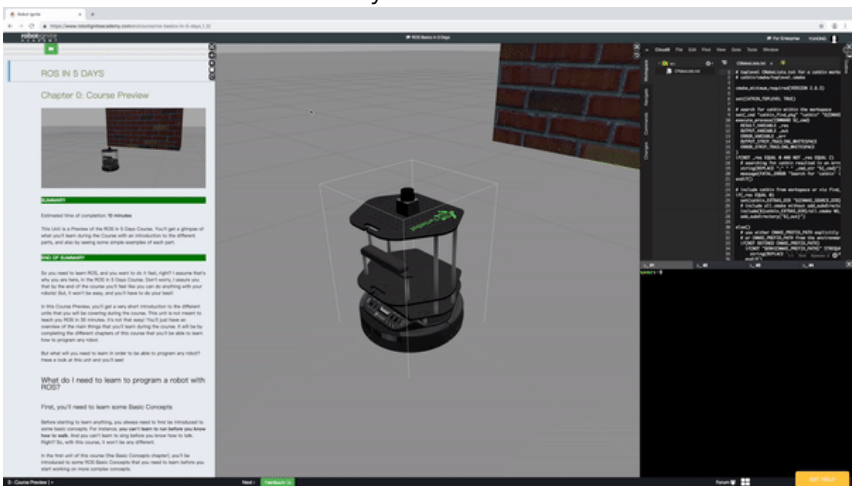

## About The Construct

The Construct is an online platform designed to learn and teach robotics. From entry-level to advanced, The Construct meets all your needs on your path to becoming a robotics & ROS developer. Learn more at https://www.theconstructsim.com/

# Frequently Asked Questions

## IS THIS MASTERCLASS VIDEO-BASED?

The courses are not based on videos but on notebooks (as shown in the image below) which contain lectures, exercises, assignments, and exams that will guide you through the program. You can also access the notebooks for review at any time.




The courses are also based on regular meetings with your mentor. You will have a mentor assigned to follow your progress. In a weekly session, your mentor will provide feedback related to your development, including areas of strength and improvement.

## CAN I COMPLETE THE COURSEWORK AT ANY TIME AND AT MY OWN PACE?

Yes. Both the full-time and part-time program schedules are flexible. You can complete the required weekly courses at any time by your own arrangement. Just be aware that you need to set aside 35 hours per week for the full-time program and 10 hours per week for the part-time program to complete the course. Also, you can talk with your mentor and agree on a schedule that ensures your success.

## WHICH STUDY MODE SHOULD I SELECT? PART-TIME OR FULL-TIME?

We recommend the FULL-TIME course option if you can commit 35 hours a week. We will guide you, communicating what material need to be done and completion dates. You can organize your work schedule to meet the work completion dates.
If you cannot commit to a 35-hour course schedule please consider enrolling in the PART-TIME course option.

## WHAT IS THE PRIMARY PROGRAMMING LANGUAGE IN THIS PROGRAM?

The main programming language will be C++ in Linux.
We will start the 1st phase with Python, but after that, the second phase we move quickly into C++. During the whole program, Python will be massively used in the 1st phase, and then later a little bit during the other months.

## I DO HAVE SOME EXPERIENCES WITH ROS. IF THIS PROGRAM IS MORE FOR BEGINNERS OR IF IT ALSO GOES INTO PRETTY ADVANCED STUFF?

Yes we are going into advanced stuff like manipulation and grasping with perception all in ROS, as well as how to work in a robotics development environment, mastering the usage of all the usual development tools and procedures, like continuous integration involving Gazebo simulations with docker and managed by Jenkins. You will also learn ROS2.

## IS THE 1-MONTH INTERNSHIP GUARANTEED UPON COMPLETION?

The internship is 100% guaranteed for all the students who do the work, study hard, and pass the program. We take charge of providing you with an internship at a robotics company, but we want to send people who have taken the course seriously.

## DOES THE PART-TIME PROGRAM INCLUDE AN INTERNSHIP?

Yes, it does. If you are employed, we trust that you can manage your time and workload.
Note, the internship is not mandatory to receive the course certificate. Instead, the internship is a way of introducing you to a real company. Do a good job there and they may offer you a job (Most ROS-based robotics companies need engineers ready to work).

## WHERE IS THE INTERNSHIP? ONLINE OR OFFLINE?

Internships are remote and in-person, dependent on where you are located and other factors. You will discuss and agree on the details for your internship with your mentor.

## CAN I CHOOSE THE INTERNSHIP LOCATION?

We will select the best suited for you based on your location, skills, and preferences. Then, you will discuss and agree on the details for your internship with your mentor.

## IS THERE ANY CONTRACT WE NEED TO SIGN BEFORE ENROLLING IN THE MASTERCLASS?

Yes, we will ask you to sign a simple contract explaining your rights and obligations.

## CAN I PAY IN INSTALLMENTS?

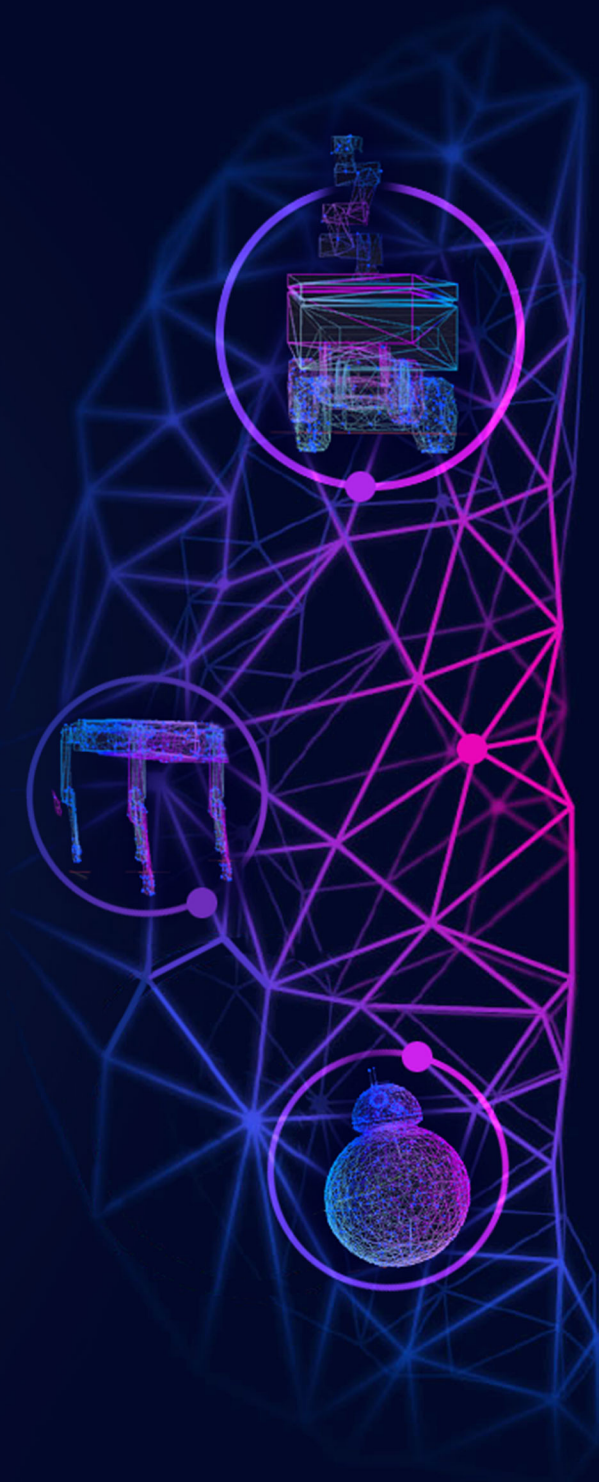
You can now register for the "Robotics Developer Master-Class" by paying in installments. You have the options to:
Pay in 2 installments: €5200 (€3000 + €2200)
Pay in 3 installments: €5500 (€2500 + €2000 + €1000)
Pay in 4 installments: €6000 (€2000 + €1700 + €1300 + €1000)
(*This pricing is only available for pre-order registration)

What do the robots of the future look like?

...it all depends on **you**.

You can enroll for the program here

**Enroll Now**



## QUESTIONS?

We're here to help and answer any questions you might have. We look forwards to hearing from you.

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Email: info@theconstructsim.com

Phone: (+34) 687 672 123


The Construct