

Robocademy.com

Online Live course

ROS Developer Learning Path 2.0 Syllabus



In collaboration with



Syllabus: ROS Developer Learning Path 2.0

- ✓ Warming up: Prerequisites for Robotics and ROS
- ✓ Let's start with the Legacy: ROS 1
- ✓ How to Migrate to ROS 2
- ✓ ROS 2 Essentials concepts with Basic Projects
- ✓ Mastering ROS 2 concepts with Intermediate Projects
- ✓ Advance ROS 2 concepts with Advance Projects
- ✓ Becoming a ROS Developer

✓ Warming up: Prerequisites for Robotics and ROS

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✓ **Introduction to Robotics and Robot Programming**

- What is a Robot?
- Robotics in a nutshell
- Different types of robots
- Applications of robotics
- Selecting sensors, actuators and computing units for your robot
- Building your own robot
- What is Robot Programming?
- How to program a robot?
- Software frameworks for programming robots

✓ **Learning Basics of Electronics & Embedded Systems**

- Learning Basic electronics for building a robot
- Choosing electronics components for building a robot
- Introduction to IO boards: Arduino, Tiva C Launchpad, Raspberry Pi Pico.
- Introduction to Single Board Computers (SBC): Raspberry Pi, Odroid, Jetson Nano

✓ Warming up: Prerequisites for Robotics and ROS

✓ **Learning Basics of Ubuntu/Linux:**

- Installing Ubuntu on PC/VirtualBox
- Linux basic commands for robotics
- Linux IDE & Text Editor: VS Code, nano, gedit
- Linux and I/O board communication: USB to Serial communication
- Linux and Camera interfacing
- How to customize Linux kernel for your robot
- Raspberry Pi and Linux overview, Linux commands, GPIO handling

✓ **Learning Basics of C++ and Python:**

- Learning C++ for Robotics and ROS: Fundamentals
- Learning Python for Robotics and ROS: Fundamentals

✓ **Learning Basics of libraries Qt, OpenCV, PCL :**

- Qt Fundamentals
- OpenCV Fundamentals
- PCL Fundamentals

✓ Warming up: Prerequisites for Robotics and ROS

✓ **Learning Basics of Git(Version Control System):**

- What is a version control system?
- What is Git?
- What is Github and how to create a repository in Github
- Basic concepts of Git:
- Creating your Git portfolio and starting your first project in Git
- Creating your own blog using Github

✓ **Learning Basics of Docker and Virtualization Software:**

- What is Docker?
- Getting started with the basics of docker

✓ **Enhance your portfolio/visibility in web and getting a job in Robotics**

- How to use LinkedIn effectively?
- How to use Github effectively?
- Creating your own YouTube channel
- Creating a website/blog
- How to start working & collaborate with Opensource projects

✓ Warming up: Prerequisites for Robotics and ROS

✓ **Learning Basics of Mechanical design & 3D Modeling in Robotics:**

- Basics concepts in mechanical design
- Basics concepts of 3D Modeling
- Overview of SolidWorks, Fusion 360, Free CAD, Blender for robot modeling
- Basic robot modeling using Fusion 360

✓ **Learning Basics of 3D Printing for Robot Prototyping**

- Getting started with 3D printing
- Modeling using Fusion 360 and printing using a 3D printer
- Printing and assembling a robot model in 3D Printer
- Best practices in 3D printing

✓ **Learning Basics of Robot Simulator**

- Getting started with Robot simulator concepts
- Overview of different robotic simulators: Webots, Ignition, Gazebo & CoppeliaSim

✓ Let's start with the Legacy: ROS 1

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✓ **Kickstarting Robot programming using ROS 1**

- What is Robot Programming?
- Getting started with ROS
 - ROS Equation
 - Why use ROS?
 - Installing ROS
 - ROS Architecture and concepts
 - ROS Filesystem
 - ROS Coding styles, IDE
 - ROS Hello World
 - ROS TurtleSim

✓ **Programming with ROS – Part 1**

- ROS Workspace and package
- ROS Client libraries: roscpp & rospy
- Understanding roslaunch, rosbag, Rviz, rqt
- Implementing Topics, Service, Parameters
- Learning ROS programming using TurtleSim: roscpp and rospy
 - Understanding ROS concepts using TurtleSim
 - Moving TurtleSim using ROS programming

✓ Let's start with the Legacy: ROS 1

✓ **Programming with ROS – TF Part 2**

- What is ROS TF?
 - Understanding Transformation and frames
 - Working with TF broadcaster and listener
 - Creating TF for your robot
 - Working with ROS TF tools
 - TurtleSim projects
 - Draw your caricature using TurtleSim
 - Object tracking using TurtleSim

✓ **Modeling a robot in ROS using Fusion 360**

- What is URDF & xacro?
 - Understanding URDF & xacro
 - Writing your own URDF and xacro
 - Visualizing your robot
 - Interacting with the robot model
 - Moving the robot model
 - Modeling robot using Fusion 360

✓ Let's start with the Legacy: ROS 1

✓ **Simulating your robot using Gazebo**

- Introduction to Gazebo simulator
- Getting started with Gazebo
 - Gazebo models and plugins
 - Spawning models into Gazebo
 - Interacting with a simulated robot
 - Working with Husky, Turtlebot3, and x-arm simulation
 - Visualizing robot sensor data in Rviz
- Creating your own mobile robot and robot arm simulation (Fusion 360)
 - Visualizing robot in Rviz
 - Introduction to ROS controllers
 - Interacting with robot models
 - Moving robots using ROS programming

✓ **Simulating Jetbot in Gazebo**

- Exploring Jetbot robot
- Simulating Jetbot in ROS

✓ Let's start with the Legacy: ROS 1

✓ **Working with ROS perception**

- What is robot perception?
- Introduction to ROS perception stacks
- Working with ROS OpenCV and Point Cloud
 - Robotic vision using OpenCV and ROS
 - Point cloud processing using PCL and ROS
 - Example projects using OpenCV and PCL
- ROS and Object detection: YOLO ROS interface
- ROS and 3D Object detection

✓ Let's start with the Legacy: ROS 1 | Projects

✓ **ROS and Embedded System programming**

- Introduction to ROS serial
- Working with ROS and Arduino
- Working with ROS and Tiva C Launchpad
- Working with Jetson Nano and ROS
- Setting ROS vision in Jetson Nano
- Working with ROS and Raspberry Pi
 - Interfacing RPI camera to ROS
 - Interfacing GPIO pins of RPI using ROS
 - Interfacing sensors to RPI and ROS
 - Controlling motors from RPI and ROS
 - Implementing a PID controller using RPI and ROS

✓ Let's start with the Legacy: ROS 1 | Projects

✓ **Building cheapest autonomous mobile robot using ROS**

- What is an autonomous mobile robot?
- Creating a robot model of a delivery robot
- Understanding the basics of ROS navigation stack
- Interfacing our mobile robot to ROS navigation stack
 - Implement Mapping and Localization using SLAM and AMCL
 - How to tune Navigation parameters
 - Commanding robot using GUI

✓ Let's start with the Legacy: ROS 1 | Projects

✓ **Building Pick-Place application using Robotic arm**

- Introduction to ROS MoveIt!
- Interfacing Simulated robotic arm to MoveIt!
- Path planning using MoveIt!
- Grasping using MoveIt!
- Implement pick-place using MoveIt! and Gazebo

✓ **ROS and State Machines**

- Introduction to SMACH, SMAC and Flexbe
- Creating state machines using Flexbe
- Creating Navigation and Manipulation using Flexbe

✓ Let's start with the Legacy: ROS 1 | Projects

✓ **ROS Nodelets**

- Deep dive into ROS Nodelets
- Writing your first Nodelets
- Implementing vision algorithms using ROS nodelets

✓ **ROS-Gazebo plugins**

- Deep dive into ROS Gazebo plugins
- Writing your first Gazebo plugin
- Implementing a sensor using Gazebo plugin

✓ Let's start with the Legacy: ROS 1 | Projects

✓ **ROS Path planners**

- Deep dive into ROS based path planners
- Working with existing planners in ROS
- Configuring a planner for your robot
- Writing your own planner for your robot

✓ **Rviz and Rqt plugins**

- Deep dive into Rviz and Rqt plugins
- Working with existing Rviz and Rqt plugins
- Creating new Rviz plugin for visualization
- Creating new Rqt plugin

✓ Let's start with the Legacy: ROS 1 | Projects

✓ **ROS-SLAM**

- List of SLAM wrappers in ROS
- Gmapping, Cartographer
- Deep dive into Visual SLAM
- Configuring different SLAM package for your robot

✓ **ROS-Controllers**

- Deep dive into Controllers in ROS
- Configuring ROS controllers for your robot
- Writing ROS controllers for your robot
- Interfacing ROS controllers to actual actuator

✓ Let's start with the Legacy: ROS 1 | Projects

✓ **ROS Drones Projects: ArduPilot and Pixhawk**

- A Brief overview of ArduPilot and Pixhawk
- Simulation and Drone in ROS and Gazebo
- ROS with MavROS
- Gazebo simulation using Pixhawk
- Mapping and Localization

✓ **ROS and Legged Robots**

- Introduction champ project
- Simulation of Boston Dynamics Spot robot
- Mapping and Navigation using Legged robot
- Prototyping lesson of mini legged robot
- Open Dynamic Robot Initiative

✓ Let's start with the Legacy: ROS 1 | Projects

✓ **ROS 1 Miscellaneous Projects**

- ROS and Virtual Reality Projects
- ROS based mobile manipulation demo projects
- ROS android applications
- ROS and Alexa interfacing
- ROS and IoT applications

✓ Let's start with the Legacy: ROS 1 | Projects

✓ **Docker for ROS App deployment**

- Mastering Docker concepts and commands
- Working with Docker-ROS container
- Deploying your ROS app in docker
- Working with NVIDIA Docker and ROS
- Working with ROS Gazebo with Docker

✓ **Testing and Deployment of your Code**

- Mastering GitHub and Travis CI for ROS project
- Creating and pushing a ROS project in GitHub
- Integrating Continuous Integration using Travis CI
- Releasing your ROS package
- Adding your own package in ROS distro

✓ Let's start with the Legacy: ROS 1 | Projects

✓ **Making robots ready for the real world**

- Diagnosis and optimization of robotics software
- Remote monitoring and operation of robot fleets
- Interacting with humans
- Interacting with other systems (IoT, smart buildings, enterprise applications)
- Optimizing robotics applications
- The rise of robot interoperability standards
- Industry applications and deployment models (RaaS)
- Robot Web Tools: ROS stack for interacting with the Web world
- rosjava: developing Android interfaces with ROS support
- Exploring typical interfaces and APIs with the free InOrbit RobOps platform
- AWS RoboMaker for deployments and simulations

✓ How to Migrate to ROS 2

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✓ Migrating from ROS1 to ROS 2

- Migrating from ROS 1 to ROS 2
- Installing ROS 2 on Ubuntu
- Understanding main architecture difference between ROS 1 & ROS 2
- Comparing ROS 1 & ROS 2 concepts
- Comparing ROS 1 & ROS 2 programming
- Comparing ROS 1 & ROS 2 simulation in Gazebo

✓ ROS 2 Essentials concepts with Basic Projects

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✓ **Kickstarting Robot programming using ROS 2**

- Getting started with ROS 2
 - ROS 2 Equation
 - Why use ROS 2?
 - Installing ROS 2
 - ROS 2 Architecture and concepts
 - ROS 2 Filesystem
 - ROS 2 Coding styles, IDE
 - ROS 2 Hello World
 - ROS 2 TurtleSim

✓ **Programming with ROS 2 – Part 1**

- ROS 2 Workspace and package
- ROS 2 Client libraries: rcl & rclpy
- Understanding roslaunch, rosbag, rviz, rqt
- Implementing Topics, Service, Parameters
- Learning ROS programming using TurtleSim: rcl & rclpy
 - Understanding ROS 2 concepts using TurtleSim
 - Moving TurtleSim using ROS 2 programming

✓ ROS 2 Essentials concepts with Basic Projects

✓ **Programming with ROS 2 – TF Part 2**

- What is ROS 2 TF?
 - Understanding Transformation and frames
 - Working with TF broadcaster and listener
 - Creating TF for your robot
 - Working with ROS 2 TF tools
 - TurtleSim projects
 - Draw your caricature using TurtleSim
 - Object tracking using TurtleSim

✓ **Modeling a robot in ROS 2 using Fusion 360**

- What is URDF & xacro?
 - Understanding URDF & xacro
 - Writing your own URDF and xacro
 - Visualizing your robot
 - Interacting with the robot model
 - Moving the robot model
 - Modeling robot using Fusion 360

✓ ROS 2 Essentials concepts with Basic Projects

✓ **Simulating your robot using Gazebo**

- Introduction to Gazebo simulator
- Getting started with Gazebo
 - Gazebo models and plugins
 - Spawning models into Gazebo
 - Interacting with a simulated robot
 - Working with Turtlebot3 and Rover robot
 - Visualizing robot sensor data in Rviz
- Creating your own mobile robot and robot arm simulation (Fusion 360)
 - Visualizing robot in Rviz
 - Introduction to ROS controllers
 - Interacting with robot models
 - Moving robots using ROS 2 programming

✓ ROS 2 Essentials concepts with Basic Projects

✓ **Working with ROS 2 perception**

- What is robot perception?
- Introduction to ROS 2 perception stacks
- Working with ROS 2 OpenCV and Open3D
 - Robotic vision using OpenCV and ROS
 - Point cloud processing using Open3D and ROS
 - Example projects using OpenCV and Open3D
- ROS 2 and Object detection: YOLO ROS interface
- ROS and 3D Object detection

✓ ROS 2 Essentials concepts with Basic Projects

✓ **ROS and Embedded System programming**

- Introduction to microROS
- Installing microROS on Arduino, Teensy, Raspberry Pico
- Interfacing motors & sensors to microROS
- ROS 2 on Jetson Nano

✓ ROS 2 Essentials concepts with Basic Projects

✓ **Building autonomous food delivery mobile robot using ROS**

- What is an autonomous mobile robot?
- Creating a robot model of a delivery robot
- Setup robot hardware and electronics for the robot
- Understanding the basics of ROS 2 navigation stack
- Interfacing our mobile robot to ROS 2 navigation stack
 - Implement Mapping and Localization using SLAM and AMCL
 - Commanding robot using GUI
- Simulation of Jetbot and Turtlebot 3 in Gazebo

✓ ROS 2 Essentials concepts with Basic Projects

✓ **ROS 2 Ignition and Webots**

- Introduction to Ignition simulation
- Interfacing Ignition to ROS 2
- Simulate a basic robot in Ignition and ROS 2
- Introduction to Webots
- Interfacing Webots to ROS2
- Simulate a basic robot in Webots and ROS 2

✓ **ROS 2 and ISAAC Simulator**

- Introduction to Isaac simulator from NVIDIA
- Interfacing Isaac to ROS 2
- Simulate a basic robot in Ignition and ROS 2

✓ Mastering ROS 2 concepts with Intermediate Projects

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- ✓ **Mastering ROS Navigation stack 2**
 - Deep dive into ROS Navigation stack
 - Configuring and fine-tuning navigation stack
 - Working with Navigation stack 2 and Behavior trees
 - Using different path planners in Navigation stack
 - Deep dive into ROS navigation node
- ✓ **Mastering ROS MoveIt! 2**
 - Deep dive into ROS MoveIt! 2
 - Configuring and fine tuning MoveIt! 2 for any robot
 - Using different planners in MoveIt!
 - Interfacing perception to MoveIt! 2
 - Complex motion planning and pick-place
 - Programming using MoveIt! 2 APIs

- ✓ Mastering ROS 2 concepts with Intermediate Projects
- ✓ **Mastering ROS 2 and Deep Learning**
 - Deep dive into ROS 2 interface of OpenCV and PCL
 - Interfacing ROS 2 and Tensor Flow
 - Interfacing ROS 2 and Pytorch
 - Object detection using ROS 2 and deep learning - NVIDIA

✓ Mastering ROS 2 concepts with Intermediate Projects

✓ **Docker for ROS 2 App deployment**

- Mastering Docker concepts and commands
- Working with Docker-ROS container
- Deploying your ROS app in docker
- Working with NVIDIA Docker and ROS
- Working with ROS Gazebo with Docker

✓ **Testing and Deployment of your Code**

- Mastering GitHub Actions and Travis CI for ROS project
- Creating and pushing a ROS 2 project in GitHub
- Integrating Continuous Integration using Travis CI
- Releasing your ROS 2 package
- Adding your own package in ROS distro

✓ Mastering ROS 2 concepts with Intermediate Projects

✓ **ROS 2 Intermediate Projects**

- ROS 2 Deep learning projects
- ROS 2 Navigation application
- ROS 2 Manipulation applications

✓ Advance ROS 2 concepts with Advance Projects

✓ Advance ROS 2 concepts with Advance Projects

✓ **ROS 2 -SLAM**

- List of SLAM wrappers in ROS 2
- Gmapping, Cartographer
- ROS 2 and SLAM TOOL Box
- Deep dive into Visual SLAM
- Configuring different SLAM package for your robot

✓ **ROS 2 Controllers**

- Deep dive into Controllers in ROS
- Configuring ROS controllers for your robot
- Writing ROS controllers for your robot
- Interfacing ROS controllers to actual actuator

✓ Advance ROS 2 concepts with Advance Projects

✓ **ROS 2 - Gazebo & Ignition plugins**

- Deep dive into ROS Gazebo plugin
- Writing your first Gazebo plugin
- Implementing a sensor in Gazebo using plugin

✓ Advance ROS 2 concepts with Advance Projects

✓ **ROS 2 Navigation & Path planners**

- Deep dive into ROS 2 based path planners
- Working with existing planners in ROS
- Configuring a planner for your robot
- Writing your own planner for your robot

✓ **Rviz 2 and Rqt Plugins**

- Deep dive into Rviz and Rqt plugins
- Working with existing Rviz and Rqt plugins
- Creating new Rviz plugin for visualization
- Creating new Rqt plugin

✓ Advance ROS 2 concepts with Advance Projects

✓ **ROS 2 in Self-driving cars**

- Deep dive into the self-driving car technology
- Discussing hardware to build a self-driving car
- Discussing the software architecture
- ROS based software for self-driving car
- Working with Autoware project
- Simulating and Visualizing a self-driving car
- Visualization of Self-driving data in Webviz & XRVIZ

✓ **ROS 2 Deep learning**

- Deep dive into Deep learning frameworks
- Interfacing deep learning frameworks to ROS: TensorFlow and PyTorch
- Working with Object detection using ROS NVIDIA deep learning stacks

✓ Becoming a ROS Developer

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✓ **Becoming a ROS Developer**

- List of robotics companies working on ROS and Robotics
- Common interview questions for ROS developer
- Mock exams for ROS developer
- Mock interviews for a ROS developer
- More reference and materials

✓ Internship