# Syllabus
# Autonomous Systems, 6hp

Issued by the WASP graduate school management group 2023-06-24.

## Main field of study

AS, Software, AI/MLX, AI/math

## Course level

PhD student course

## Course offered for

PhD Students in the WASP graduate school

## Entry requirements

The course requires

- solid programming experience in a high-level language; the programming assignments will use Python and Matlab.
- a background in mathematics corresponding to the contents of the WASP-course "Mathematics and Machine Learning".

## Intended learning outcomes

Autonomous systems are systems that are designed to work without, or with limited, human intervention. This course covers autonomous systems concepts and focuses on mobile physical systems. The objective of this course is to give a basic understanding of some of the core components that make up autonomous systems, from sensing and perception to planning and control, and to illustrate how these interact.

On completion of the course, the student should be able to

- Explain what autonomy is and what challenges it poses for a system.
- Describe basic properties of common sensors in autonomous systems.
- Explain the principles for fusing sensor information in autonomous systems.
- Use learning-based methods for perception in autonomous systems.
- Explain the principles of motion planning in autonomous systems.
- Explain the principles of automatic control in autonomous systems.
- Use some common software tools for the design of autonomous systems.

## Course content

In this course we will look at some of the building blocks of autonomous systems along with some common software tools. A traditional and highly simplified model of a system divides it into sensing, planning, and acting.

Sensors allow an autonomous system, be it an autonomous truck, a service robot, or an autonomous forklift, to gather information about the internal state (temperature, electrical currents, etc.) and the state of the surrounding world as well as its position in that world. We will look at different sensors and study the type of data they provide, where they are applicable, and what their strengths and weaknesses are. The problem of perception is to process raw data from the sensors to extract information that can be used by the autonomous system. We will look at two examples of this; 1) the problem of estimating the position of a vehicle using a traditional, model-based, approach to sensor fusion; and 2) how learning-based models can be employed to solve many perception problems, such as detecting objects. Given the information extracted from the sensors and refined with perception methods, we will study motion planning. Finally, we look at controlling a system so that some objective, such as position or speed, is met or that the previously computed motion plan is executed.

## Teaching and working methods

There are an endless number of different autonomous systems. To make the content of the course concrete we will focus on a small set of systems which we will first present and then use to illustrate and connect the content of the course. We will make use of the Robot Operating System (ROS) in the course. This is the de facto standard in this discipline in research and is also often used in industry, for example, for prototyping.

The course starts with a 2-day in-person meeting. At this meeting we will introduce the course setup in more detail, present the example systems and then start working with ROS and the first assignment so that everyone gets a good start.

After this the students will work on assignments in a roughly three-week cycle with one online help-session per assignment. The assignments will require the students to program in Python and Matlab. Interaction between students will always be encouraged and enforced in some cases via group work.

The course concludes with a second 2-day in-person meeting which will feature a mix of examination, group work and lectures.

## Examination

The examination in the course consists of four assignments to be completed individually and in groups. Some of the assignments or parts thereof will be carried out or examined during the in-person 2-day meetings to allow for more interaction and better support.

A re-examination will be made available, upon request, about 6 months after the course covering completion of missing parts.

## Grades

Fail or Pass