

**Module Description, available in: EN**

## *Advanced robotics*

**General Information****Number of ECTS Credits**

3

**Module code**

TSM\_AdvRobot

**Valid for academic year**

2025-26

**Last modification**

2024-10-17

**Coordinator of the module**

Gabriel Gruener (BFH, gabriel.gruener@bfh.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

	Lausanne			Lugano	Zurich		
<b>Instruction</b>					X E 100%		
<b>Documentation</b>					X E 100%		
<b>Examination</b>					X E 100%		

**Module Category**

TSM Technical scientific module

**Lessons**

2 lecture periods and 1 tutorial period per week

**Entry level competences****Prerequisites, previous knowledge**

- Linear algebra and differential equations
- Feedback control systems
- Actuation and sensory systems
- Basic programming skills
- Basic robotics knowhow (recommended)

## Brief course description of module objectives and content

In this module, basic and advanced robotics knowhow is developed necessary for leading-edge, innovative industrial and service applications with robot manipulators.

## Aims, content, methods

### Learning objectives and acquired competencies

At the end of this course, the student will have earned the knowledge necessary to build a complete robot system as well as acquired the skills to develop industrial and service applications based on commercial robots beyond their standard interfaces.

### Contents of module with emphasis on teaching content

- **Robot Kinematics**
  - Homogeneous transformation matrices and quaternions
  - Forward, inverse and instantaneous kinematics of serial and parallel robots
  - Kinematic redundancies and subspaces
  - Trajectory generation
- **Robot Dynamics**
  - Motion state: speed, acceleration and jerk
  - Dynamic models of multibody systems
  - Robot dynamic equations for simulation and control
- **Robot Control**
  - Linear and nonlinear control
  - Trajectory, force and hybrid control
  - Adaptive, model-based, vision-based control
  - Haptic control
- **Robot Design**
  - Task requirements and kinematic configuration
  - Joint types, actuators, sensors, communication busses and architectures
  - Control systems and real-time restrictions
- **Applications**
  - Industrial and service use cases
  - Collaborative and interactive robots
  - Research topics
  - Safety and ethics in robotics

### Teaching and learning methods

- Ex-cathedra teaching
- Case studies
- Exercises
- The theory learned in class is applied in real robotic applications

### Literature

- B. Siciliano, O. Khatib eds., "Springer Handbook of Robotics", Springer-Verlag, Berlin, 2016.
- J. J. Craig, "Introduction to Robotics: Mechanics and Control", 3rd edition, Pearson Prentice Hall, USA, 2005.
- P. Corke, "Robotics, Vision and Control - Fundamental Algorithms in Python", Springer-Verlag, Berlin, 2023.

## Assessment

### Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

All electronic aids permitted except AI and communication tools.

**Other permissible aids**

Open book

**Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.**

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

All electronic aids permitted except AI and communication tools.

**Other permissible aids**

Open book