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		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**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 competencies to be acquired

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.

Module content with weighting of different components

- **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 standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

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 exam

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