MASTER OF SCIENCE
IN ENGINEERING

Module Description, available in: EN

Model predictive control

General Information

Number of ECTS Credits

3

Module code

TSM_PredContr

Valid for academic year

2022-2023

Last modification

2021-01-12

Coordinator of the module

Konrad Stadler (ZHAW, stdl@zhaw.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
- Differential equations
- Basic feedback control and dynamic systems
- Basic programming skills in Matlab or Python or equivalent
- General affinity to mathematics(!)

Brief course description of module objectives and content

Model Predictive Control (MPC) is an optimisation-based approach to control systems and processes. The general mathematical formulation of MPC allows it to be applied to a broad range of systems and considers system constraints intrinsically. The advances in optimisation methods and available computational power have made MPC a valuable alternative to classical control approaches also for fast dynamic systems. Today, MPC applications can be found from the original chemical process control systems to the control of frequency converters with sampling periods down to a few microseconds.
This module focuses on introducing MPC from the theoretical basics to the use of tool kits to support the implementation and generation of working code. As the classical frequency domain control methods are not considered here, this module does not need in-depth knowledge of control systems. A general affinity to mathematics and programming skills are beneficial.

Aims, content, methods

Learning objectives and acquired competencies

The student is able to

- formulate an optimisation problem and solve it with appropriate tool kits
- formulate model predictive control problems
- apply MPC concepts to real world systems and generate executable code which runs on their control systems

Contents of module with emphasis on teaching content

Basic concepts (3W)

- Introduction to state space models in continuous and discrete time
- Introduction to optimisation (linear quadratic programs) using tool kits like YALMIP
- Introduction to optimisation with constraints

Basic MPC (3W)

- Linear MPC problem formulation
- Receding horizon concepts
- Limits of MPC

MPC Extensions and examples (5W)

- Reference tracking
- Error free tracking

- Nonlinear optimisation and MPC with nonlinear models
- Buck converter control (explicit MPC) -- optional

- Energy management (scheduling) -- optional

Real-time implementation(3W)

- From problem to code using tool kits like ACADO

Teaching and learning methods

Lectures with homework assignments which are a mix of theoretical exercises and programming assignments.

Literature

Assessment

Certification requirements

Module uses certification requirements

Certification requirements for final examinations (conditions for attestation)

Attendance of at least 9 tutorials.

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

Personal PC with Matlab/Simulink

Other permissible aids

Open book

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

Personal PC with Matlab/Simulink

Other permissible aids

Open book