

Module Handbook (<https://modhb.uni-kl.de/>)

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Module EIT-JEM-515-M-7

Model Predictive Control (M, 4.0 LP)

Module Identification

Module Number	Module Name	CP (Effort)
EIT-JEM-515-M-7	<i>Model Predictive Control</i>	4.0 CP (120 h)

Basedata

CP, Effort	4.0 CP = 120 h
Position of the semester	1 Sem. in WiSe
Level	[7] Master (Advanced)
Language	[EN] English
Module Manager	Görges, Daniel, apl. Prof. Dr.-Ing. (EXT DEPT: EIT) (/staff/618/)
Lecturers	Görges, Daniel, apl. Prof. Dr.-Ing. (EXT DEPT: EIT) (/staff/618/)
Area of study	[EIT-JEM] Electro Mobility
Reference course of study	[EIT-88.-SG#2021] M.Sc. Automation and Control (A&C) [2021] (/mhb/FB-EIT/cos-676/)
Lifecycle-State	[NORM] Active

Courses

Type/SWS	Course Number	Choice in Module-Part	SL	PL	CP	Sem.
2V+1U	EIT-JEM-515-K-7 (/mhb/courses/EIT-JEM-515-K-7/)	P	-	PL1	4.0	WiSe

- About [EIT-JEM-515-K-7]: Title: "Model Predictive Control"; Presence-Time: 42 h; Self-Study: 78 h

Examination achievement PL1

- Form of examination: **written exam (Klausur) (90 Min.)**
- Examination Frequency: each semester

Evaluation of grades

The grade of the module examination is also the module grade.

Contents

From [EIT-JEM-515-K-7] **Model Predictive Control** (/mhb/courses/EIT-JEM-515-K-7/):

- Introduction to model predictive control (concept, variants, applications, research)
- Fundamentals of discrete-time systems (structures, discretization, stability, state feedback control, controllability, state observation, observability, separation principle, reference tracking, integral control, disturbance rejection, disturbance estimation, illustration for an active suspension system)
- Fundamentals of optimization (nonlinear optimization, convex optimization, optimality conditions, linear programming, quadratic programming)
- Model predictive control without constraints (formulation and solution of the optimization problem for a finite horizon (system model, cost function, analytical solution), application of the solution for a receding horizon, formulation and solution of the optimization problem for an infinite horizon (LQR), comparison)
- Model predictive control with constraints (Types and handling of constraints, formulation and solution of the optimization problem for a finite horizon (constraint models, numerical solution), application of the solution for a receding horizon, extensions like warm starting, multiple horizons, scaling, linear cost and soft constraints)
- Stability and feasibility (stability of model predictive control without constraints, feasibility and stability of model predictive control with constraints)
- Reference tracking and disturbance rejection (reference tracking based on target calculation and the delta input formulation, disturbance rejection based on disturbance estimation, preview control)
- Robust model predictive control (polytopic and norm-bounded uncertainties, linear matrix inequalities, parameter-dependent Lyapunov functions, robust stability and control)
- Illustration of the contents using simulations in MATLAB/Simulink

Competencies / intended learning achievements

After completing this module you can...

- ... describe the variants and applications of model predictive control.
- ... explain the theoretical background of model predictive control (optimization, stability, feasibility, robustness, reference tracking, disturbance rejection).
- ... analyze the stability and feasibility of model predictive controllers.
- ... design, implement and evaluate model predictive controllers using MATLAB/Simulink.

Requirements for attendance (informal)

Modules:

- [EIT-LRS-504-M-3] Linear Control (M, 5.0 LP) (/mhb/modules/EIT-LRS-504-M-3/)

Requirements for attendance (formal)

None

References to Module / Module Number [EIT-JEM-515-M-7]

Course of Study	Section	Choice/Obligation
[EIT-88.781-SG#2010] M.Sc. Electrical and Computer Engineering [2010] (/mhb/FB-EIT/cos-556/)	Elective Subjects	[W] Elective Module
[EIT-88.?-SG#2021] M.Sc. Electrical and Computer Engineering [2021] (/mhb/FB-EIT/cos-686/)	Technical Elective Modules	[W] Elective Module
[EIT-88.A20-SG#2021] M.Sc. European Master in Embedded Computing Systems (EMECS) [2021] (/mhb/FB-EIT/cos-566/)	Elective Subjects	[W] Elective Module
[EIT-88.?-SG#2021] M.Sc. Automation and Control (A&C) [2021] (/mhb/FB-EIT/cos-676/)	Major "Connected Automation Systems" (CAS)	[P] Compulsory
[EIT-88.?-SG#2021] M.Sc. Embedded Computing Systems (ESY) [2021] (/mhb/FB-EIT/cos-677/)	Elective Subjects	[W] Elective Module