Modelling and System Identification for Model Based Control

VO 325.107 (lecture, 2.0h, 3.0EC), summer term 2025. [info sheet as of 14th Mar. 2025]

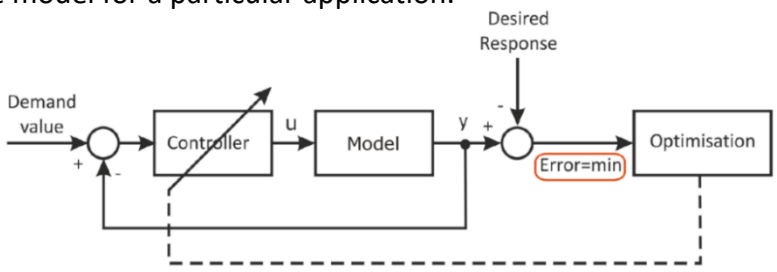
Schedule

Unit	Calendar week	Topic
1	19	Course introduction, regression, least squares, curve fitting, introduction to neural networks, optimisation, learning.
2	20	Linear dynamic systems, systems identification of linear systems, adaptive control, introduction to nonlinear dynamic systems.
3	21	Systems identification of nonlinear systems, local model networks, blended multi-model systems, examples of utilisation of such models for control.
4	23 and 24	Nonlinear systems identification with Gaussian process models, model inversion, examples of utilisation of GP models for control.
5	24	Application of modelling techniques presented in course for industrial model-based control, course conclusions, preparation for exam.

Course Contents

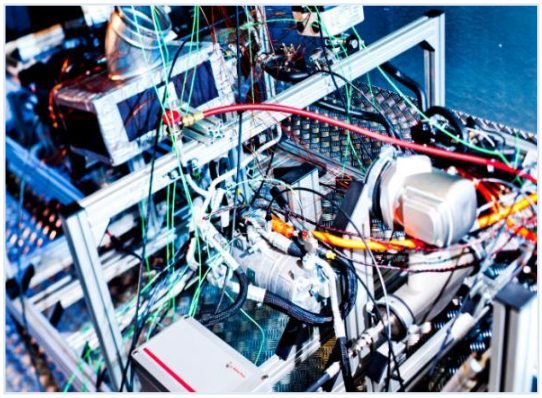
The course will cover **advanced model design** and **system identification techniques** for modelling of dynamic systems in engineering practice.

The paradigms presented are tailored in such a way to **obtain models which can then be employed in model-based control strategies**. Different model-based control methodologies such as **model predictive control**, **internal model control**, **adaptive control**, etc. embody different classes of models with various types of structures and parametrisations. Since the efficiency and quality of a model-based control is strongly related to the accuracy of the internal model, it is therefore important to select a modelling technique which will generate the best possible model for a particular application.



Modelling approaches such as local model networks, Takagi-Sugeno fuzzy models, neural networks and support vector machines, as well as probabilistic models like Gaussian processes will be presented. Pros and cons of each of them will be highlighted. Machine learning, artificial intelligence and adaptive algorithms for structure identification and parametrisation will be presented in detail. Comon difficulties related to AI modelling methodologies, such as the curse of dimensionality, rank deficiency, overfitting, bias-variance trade-off and off-

equilibrium dynamics will be pointed out, and practical guidelines how to overcome them will be given. Model properties such as transparency and inevitability will also be discussed.
The presented modelling techniques for model-based control will be demonstrated on **industrial examples** taken from **automotive applications and process control**.



Scientific computing, simulation and animation software will extensively be used in order to provide an efficient and attractive presentation of course material.

Lectures will be held in English.

Venue and Time

Lectures will be given at TU Wien, building BA, above the AudiMax, Getreidemarkt 9, 1060 Vienna, as well as online distance lectures on following dates:

Unit	Date			Time	Venue
1	CW 19	Fri	May 9th 2025	10:00 – 12:00	Seminar room BA08B (8th floor)
1	CW 19	Fri	May 9th 2025	13:30 – 15:30	Seminar room BA08B (8th floor)
2	CW 20	Tue	May 13th 2025	10:00 – 12:00	Online
2	CW 20	Thu	May 15th 2025	15:00 – 17:00	Online
3	CW 21	Tue	May 20th 2025	10:00 – 12:00	Online
3	CW 21	Thu	May 22nd 2025	15:00 – 17:00	Online
4	CW 23	Fri	June 6th 2025	10:00 – 12:00	GM 5 Praktikum HS (basement)
4	CW 23	Fri	June 6th 2025	13:30 – 15:30	Seminar room BA08B (8th floor)
4	CW 24	Fri	June 13th 2025	10:00 – 12:00	Seminar room BA08B (8th floor)
5	CW 24	Fri	June 13th 2025	13:30 – 15:30	Seminar room BA08A (8th floor)

Exam

The preferred examination mode is an **oral exam**, planned to be held in June 2025. The date and time are yet to be announced.

Lecturers

Dr. Gregor **Gregorcic**, PhD	gregor.gregorcic@tuwien.ac.at
Univ.Ass. Dipl.-Ing. Dr.techn. Alexander **Schirrer**	+43-1-58801-325521

If there are any questions, please ask in the lecture or contact us at the institute:
building BA, 5th / 6th floor above the AudiMax, Getreidemarkt 9.

- In lectures many examples are demonstrated by MATLAB/Simulink
- A special student-version of MATLAB/Simulink is available online through TU.it
- Additional MATLAB/Simulink stuff:
  - Mathworks-HP
  - „Getting Started“ Book (pdf)
  - MATLAB-Einführung (Technikum Wien)