Agenda for Workshop/Training Course 29th April to 1st May 2025

Control Fundamentals Course II Agenda

Engineering Practice and Optimization

Motivation for the Course: The "Control Fundamentals" course has been the most popular since it was developed and refined over two decades ago. It has been presented multiple times at companies around the world. The course was aimed at engineers that are using control techniques in their everyday work but may need updating or they may have only had an introduction to control engineering theory at university. This new course, entitled "Control Fundamentals II," goes beyond the first course material and is stand-alone, so it is not essential to have attended the first course. The practical nature is maintained but slightly more advanced techniques are covered that have proven to be the most useful in applications. These include tuning, auto-tuning, predictive control, Kalman filtering and Optimal Control methods.

The course material is motivational to encourage the use of the techniques, rather than dwelling on the mathematical basis of results. The hands-on exercises in MATLAB/Simulink software will help engineers to understand the modelling and design techniques. There is an opportunity throughout the course to interrupt and ask questions and to raise questions at the end of each presentation. There will be time in coffee and lunch breaks to talk to the instructors about engineers' problems, whether they are concerned with modelling, simulation, control, condition monitoring or problems with implementation. On the last day the wrap-up session can deal with further questions and any comments on the course content or delivery.

Agenda: Control Fundamentals Course II

Engineering Practice and Optimization

Day 1: Basics of Control and System Modelling

09.00 **Welcome, Safety and Introduction to the Course**

09.10 **L1.1 Motivation for Using Improved Control Design Methods** (Safe Control, Robustness, Reliability, Performance Benefits Obtained)

10.15 **L1.2 Physical Systems Modelling Methods** (White and Grey Box modelling, State-Space Models, Applications, Simulation Tools)

11.00 *TEA/COFFEE*

11.15 **H1.1 Hands-On Session**: System Modelling using MATLAB/SIMULINK

12.30 *LUNCH*

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13.30 **L1.3 Sensors and Actuators** (Wide ranging overview of the devices available)

14.30 *TEA/COFFEE*

14.45 **L1.4 Nonlinear Systems and Control** (Modelling and problems due to nonlinearities, linearization methods, hysteresis and compensation)

15.45 **H1.2 Hands-On Session:** Frequency Response Analysis and Design Methods

17.00 *CLOSE.*

Day 2: Identification Methods and Control Design

09.00 **L2.1 Identification of the Models for Linear Systems** (popular model-based algorithms to calculate models of systems from data collected).

10.15 *TEA/COFFEE*

10.30 **L2.2 Autotuning Methods** (automatic methods of controller tuning after obtaining test results using system identification methods including PID controllers).

11.15 **H2.1 Hands-On Session:** System Identification

12.00 **L2.3 Practical Aspects of Model Identification** (identification methods and use of methods when implementing controls).

12.45 *LUNCH*

13.45 **H2.2 Hands-On Session:** Computing Models, Control Design and Autotuning

14.45 *TEA/COFFEE*

15.00 **L2.4 State-Space Based Modelling Methods for More Advanced Control Methods** (further details of types of SS structure and models produced).

16.00 **L2.5 Introduction to Predictive Control Methods** (most successful modern control design method – motivation and basic ideas).

17.00 *CLOSE*

Day 3 Optimal Control Design and Filtering/Estimation Methods

09.00 **L3.1 An Introduction to Linear Quadratic Optimal Control Methods** (Basic ideas in optimal control and controller properties)

10.00 *TEA/COFFEE*

10.15 **H3.1 Hands-On Session:** Linear System Optimal Control Design

11.00 **L3.2 Intuitive Introduction to Optimal Filtering** (Kalman filtering and extended Kalman filtering methods for nonlinear applications).

12.00 *LUNCH*

13.00 **H3.2 Hands-On Session:** Kalman Filtering Methods and Observers

13.45 **L3.3 Design Example on Dynamic Positioning** (Positioning system design, marine application example).

14.45 *TEA/COFFEE*

15.00 **L3.4 Model Based Condition Monitoring and Fault Detection Methods** (overview of model based early detection and fault monitoring methods).

16.00 **L3.5 A Look to the Future Covering Artificial Intelligence and Machine Learning** (artificial neural networks and optimization, genetic algorithms, data driven technologies available, using machine learning in control and estimation).

16.50 *WRAP-UP SESSION AND CLOSE*

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