



Advanced Control Fundamentals Course

*Multivariable, Optimal, Robust and Predictive Control Systems Design
(includes six morning web-based sessions)*

This course is new and was designed for control specialists or to advance the learning for those that have attended the Control Fundamentals courses. It covers a range of advanced control topics in an overview and introductory form describing some of the most important problems in control design and applications:

- Modern modelling and simulation methods.
- Optimal Control and Optimisation Techniques
- Dealing with Uncertainty
- Robust and Safety Critical Control Methods
- Predictive Control to Handle Constraints
- Nonlinearities and Design Issues
- Application of Advanced Control Problems & Solutions

Course deliverables:

- Copies of the presentations are provided to all delegates.
- Hands-On MATLAB/Simulink software modelling and design examples are provided with problem and solution notes that contain clear step by step instructions.
- Presenter emails are provided so follow up questions can be answered.
- Training course certificates are issued for each attendee on completion of the course together with the course details/agenda for company training department records.

AGENDA

Day 1: Introduction to Modelling and State Estimation

09.00 L1.0 Introduction to the Course

(motivational introduction)

MJG

09.15 L1.1 Modelling Dynamic Systems to be Controlled

(Modelling of linear and nonlinear systems, model requirements, state-space models, benefits of simulation).

Luca

10.15 Tea / Coffee

10.30 L1.2 Kalman Filters and Observers for State Estimation

(Optimal estimation problems and Kalman filtering algorithms or observers for linear, time-varying and LPV systems, and for use in MPC control solutions).

MJG

11.30 H1.1 Hands-on Session: State Estimation for Systems

(Powertrain Example, Stochastic Systems, State estimation using Kalman Filter, Observers)

Luca

12.30 Close



Day 2: Introduction to Multivariable and Optimal Control

09.00 L2.1 Introduction to Multivariable Control Design and Stability

(Multivariable system models, Model Structures and Compensation, Relative Gain Array, Stability) Luca

10.00 Tea / Coffee

10.15 L2.2 Introduction to LQ and LQG Optimal Control

(Optimal Control Techniques for Linear Systems, Optimal control cost-functions, LQ control, LQG control, Natural Robustness properties) MJG

11.00 H2.1 Hands-on Session: LQ State Feedback Optimal Control and Robustness Properties (Flight Control Example, Gain & Phase Margins of state feedback solutions) Luca

11.45 L2.3 Design Example Using LQG Control

(Thickness control, Kalman filtering and LQG design example) MJG

12.30 Close

Day 3: Uncertainty in Systems

09.00 L3.1 Uncertainty in Systems and Robustness

(Modelling uncertainty, control design in presence of uncertainty). Luca

10.00 Tea / Coffee

10.15 H3.1 Hands-on Session: LQG Stochastic Control Design (Flight Control Example, Disturbance Rejection, Robustness and use of Dynamic Cost-Function Weightings) Luca

11.15 L3.2 Introduction to Robustness and H_∞ Control

(H_∞ cost measures, Standard system model control structures with uncertainty). MJG

12.30 Close



Day 4: Robust Control and H_∞ Design Methods

09.00 L4.1 Design Example Using Kalman Filtering, LQG, H_∞ Methods

(Modelling, estimation and LQG or H_∞ design stages, and results, using a positioning control design example)

MJG

10.00 H4.1 Hands-On Session: Robustness and H_∞ Robust Control System Design.

(F16 flight control H_∞ design example)

Luca

10.45 Tea / Coffee

11.00 L4.2 Quantitative Feedback Theory Robust Control Design Method

(frequency response based robust control design method, design example remote pilotless vehicle)

MJG

11.30 L4.3 Introduction to Linear Model Predictive Control

(Optimal constrained and unconstrained control, operation of basic algorithms, pros and cons).

Luca

12.30 Close

Day 5: Predictive Control Law Design

09.00 L5.1 Model Predictive Control: with Linear Parameter-Varying Models

(Use of linear parameter varying models to approximate nonlinear systems).

MJG

10.15 Tea / Coffee

10.30 L5.2 Constrained MPC and Quadratic Programming Solvers

(Convex optimization problems, Use in MPC design, Reference Governor).

Luca

11.30 H5.1 Hands-on Session: Introducing Model Predictive Control Design and Performance (vehicle suspension control problem)

Luca

12.30 Close



Day 6: Nonlinear Control Systems

09.00 L6.1 Overview of Nonlinear Control Techniques

(The range of nonlinear control design options available)

Luca/MJG

10.00 H6.1 Hands-on Session: Introducing Nonlinear Control System Problems and Design Methods

Luca

10.45: Tea / Coffee

11.00 L6.2 Servo System Design Study: for Nonlinear Control Design Applications

(Sightline Stabilisation of Electro-Optical Devices)

MJG

11.45 L6.3 Model Based Advanced Control Methods

(Summary of Important Features of Model Based Design Methods covered in the course and recent developments in areas including AI & ML).

MJG

12.30 End of Course Questions and Close