Preface

Typically, the need to use modern linear control arises when working with models which are complex, multiple input multiple output, or when optimization of performance is a concern. Any model of a real system presents inaccuracies. This is the reason why robustness with respect to system variations is one of the most important aspects in the analysis and control of dynamical systems. A system which has to guarantee certain properties, is said robust if satisfies the requirements not only for its nominal values but also in the presence of perturbations.

Basic elements of system modeling are introduced: signals are considered as functions of continuous time and finite order linear time-invariant system are considered described by state space equations, and by transfer matrices as well. Stability of systems is defined in terms of $\mathcal{L}_2$ gain. The small gain criterion is presented for analysis of stability of system interconnections.

In this course we study modern methods for designing controllers with specified optimality and robustness properties. We will cover $\mathcal{H}_2$-optimal and robust $\mathcal{H}_\infty$-optimal control, including the μ-synthesis procedure for structured uncertainties. In this course, the problem of applying optimal and robust control theory to controller design in automotive applications will also be discussed.

In controller design, the controller synthesis is only come at the final stage. For a good design it is very important to state the problem properly. In particular, the design process involves the selection of the cost function(performance) and the controlled output (performance signal) used in the controller synthesis step. The design parameters include relative weights between outputs and inputs in the cost, frequency- dependent weightings, realistic magnitudes and structures for the plant uncertainties.

Only in special instances the primary control objective can be stated directly in terms of a single cost function. Often, however, the control objectives are stated more loosely, typically requiring fast response, small overshoot, and robustness. It is then necessary to translate the control objectives into a quantitative controller synthesis problem. In this course we consider how the controller synthesis methods can be applied to achieve good controller designs in such situations.

This book is intended to be used as a textbook in our PhD course. We have tried to balance the broadness and the depth of the material covered in the book. The reader is also sent to consult the indicated references.

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