SYSTEMS THEORY (S14)

FELIX SCHWENNINGER (TWENTE)

Tuesday 16:30-19:00 (CHLT) chair: Felix Schwenninger

16:30-16:55 Andreas Buchinger
Duality for Evolutionary Equations with Applications to Control Theory
17:00-17:25 Merlin Schmitz
Operator Splitting for Optimal Control
17:30-17:55 Philip Preußler
Tests for L^p-admissibility
18:00-18:25 David Seifert
Stability of abstract coupled systems

Wednesday 11:40-12:40 (CHLT) chair: David Seifert

11:40-12:05 Sahiba Arora
Limit-case admissibility of positive systems
12:10-12:35 Mohamed Fkirine
Stochastic Admissibility and Generator Perturbations for Stochastic Cauchy Problems

Wednesday 14:00–15:00 (CHLT) chair: Sahiba Arora

14:00-14:25 Nicolas Vanspranghe
Relaxed admissibility and sharp transfer function estimates for ill-posed systems
14:30-14:55 Karsten Kruse
C-*maximal regularity and* C-*admissibility for semigroups on locally convex spaces*

Abstracts.

Sahiba Arora, University of Twente

Limit-case admissibility of positive systems

Abstract. Consider the linear time-invariant system

$$\Sigma(A,B,C) \quad \begin{cases} \dot{x}(t) = Ax(t) + Bu(t), & t \geq 0 \\ y(t) = Cx(t), & t \geq 0 \\ x(0) = x_0; & \end{cases}$$

where A generates a C_0-semigroup on a Banach space X, the *control* operator B is a bounded operator from a Banach space U mapping into the extrapolation space X_{-1}, and the *observation* operator $C \in \mathcal{L}(D(A), Y)$ for some Banach space Y. We give sufficient conditions that ensure the positivity of the system $\Sigma(A,B,C)$ automatically yields L^1-admissibility of C and L^∞-admissibility of B respectively.

To be more precise, we look at situations where all given spaces are function spaces, the operators B and/or C are positive (i.e., they map positive functions to positive functions), and the semigroup generated by A is positive (i.e., each semigroup operator is positive).

This is joint work with Jochen Glück, Lassi Paunonen, and Felix Schwenninger.

Andreas Buchinger, TU Bergakademie Freiberg

Duality for Evolutionary Equations with Applications to Control Theory

Abstract. In this talk, we will recall the theory of evolutionary equations (afforded by R. Picard). This theory provides a general well-posedness theorem that covers a vast class of PDEs. In this setting, we will introduce a natural concept of duality that gives rise to ”evolutionary control and observation”, and we will discuss consistency with classical control theory.

Mohamed Fkirine, Tampere university

Stochastic Admissibility and Generator Perturbations for Stochastic Cauchy Problems

Abstract. In this talk, we delve into the study of evolution equations with white-noise boundary conditions. By rewriting these equations as stochastic Cauchy problems, we establish necessary and sufficient conditions for the existence of solutions using the concept of admissible observation operators and the Yosida extension for such operators. Additionally, we examine the robustness properties of these equations, including well-posedness, absolute continuity, and the existence of invariant measures under various types of unbounded perturbations.

This is joint work with S. Hadd and A. Rhnadi.

References

[1] G. Da Prato, Evolution equations with white-noise boundary conditions, *Stochastics: An International Journal of Probability and Stochastic Processes* **42**(3-4) (1993), 167–182)
[2] M. Fkirine, S. Hadd, A. Rhandi, On evolution equations with white-noise boundary conditions, *Journal of Mathematical Analysis and Applications* **535**(1) (2024), 128087.
[3] M. Fkirine, S. Hadd, A. Rhandi, Impact of mixed boundary conditions on stochastic equations with white noise at boundary, *Preprint* (2024).

Karsten Kruse, University of Twente

C-*maximal regularity and* C-*admissibility for semigroups on locally convex spaces*

Abstract. In this talk we consider C-maximal regularity and C-admissibility for strongly continuous locally equicontinuous semigroups on sequentially complete locally convex Hausdorff spaces. The C here stands for *continuous* and describes the regularity of the inhomogeneity of an abstract Cauchy problem of first order involving the generator of a strongly continuous locally equicontinuous semigroup. We show that C-maximal regularity and the a priori weaker C-admissibility are equivalent for such semigroups on certain classes of locally convex Hausdorff spaces.

This contribution is a joint work with Felix L. Schwenninger [1].

References

[1] K. Kruse, F.L. Schwenninger, C-maximal regularity and C-admissibility for semigroups on locally convex spaces, *arXiv preprint* `https://arxiv.org/abs/...`, (2024), 1–36.

Philip Preußler, University of Twente

Tests for L^p*-admissibility*

Abstract. The talk will be centered around approaches for checking L^p-admissibility for infinite-dimensional linear control systems, with special focus on the case $p \neq 2$. We compare known methods based on abstract interpolation spaces, Laplace–Carleson embeddings and the p-Weiss property while giving some extensions and reviewing their applicability to infinite-dimensional input spaces. Moreover, we illustrate the theory by means of various examples based on the heat equation.

This is joint work with Felix Schwenninger.

References

[1] P. Preußler, F. L. Schwenninger, On checking L^p-admissibility for parabolic control systems, to be published in *Systems Theory and PDEs: Open Problems, Recent Results, and New Directions.* Trends in Mathematics, Birkhäuser, Cham, 2024.

Merlin Schmitz, University of Wuppertal

Operator Splitting for Optimal Control

Abstract. In this talk I will investigate a dissipativity-based time-splitting for finite-dimensional, linear-quadratic optimal control problems. This method is based on a Peaceman-Rachford algorithm that has been generalized in [1] to monotone operators. The main idea is to reformulate the problem as a state and adjoint equation, where the adjoint equation has its initial value at the other end of the time interval. Then, we decompose the time-domain into subintervals and refresh both the initial values in each iteration. Thanks to this "dichotomy" of equations, the proposed splitting algorithm has a monotonly decreasing error bound.
Joint work with B. Farkas, B. Jacob and M. Schaller.

References

[1] P.L. Lions, B. Mercier, Splitting Algorithms for the Sum of Two Nonlinear Operators, *SIAM J. Numer. Anal.* **16**, (1979), 964–979.

David Seifert, Newcastle University

Stability of abstract coupled systems

Abstract. We present an abstract framework for studying the asymptotic behaviour of coupled linear systems. Our approach combines ideas from systems theory with results in the quantitative asymptotic theory of strongly continuous operator semigroups, and it allows us to study composite systems by looking separately at the (often much simpler) constituent components and the properties of a certain “transfer function”. We illustrate the power of our abstract results by using them to obtain (typically sharp) rates of energy decay in certain wave-heat systems and for a wave equation with an acoustic boundary condition. The talk is based on joint work with Lassi Paunonen and Serge Nicaise.

Nicolas Vanspranghe, Tampere University

Relaxed admissibility and sharp transfer function estimates for ill-posed systems

Abstract. Despite their prevalence in the abstract literature, admissible control and observation operators exclude a number of classical models in the control theory of PDEs. Notably, for the multidimensional wave equation $(\partial_t^2 - \Delta)w = 0$ posed in $(0, T) \times \Omega$, it was shown by I. Lasiecka and R. Triggiani that general Neumann boundary data $u \in L^2((0, T) \times \partial\Omega)$ fail to produce finite-energy solutions (i.e., at the natural $H^1(\Omega) \times L^2(\Omega)$-level). In an attempt to bridge the gap between semigroup- or system-theoretic and PDE approaches, we investigate relaxed admissibility properties formulated in terms of abstract Sobolev scales based on the functional calculus of the semigroup generator and quadratic interpolation in Hilbert spaces. Such scales allow us to quantify the defect of admissibility and, in the group case, yield an exact correspondence between loss of regularity in the time domain and growth rates at high frequencies of certain operator-valued functions in the Laplace domain. Likewise, under mild assumptions, we are able to translate input-output regularity properties into high-frequency growth rates of the system's transfer function. As an application, we use the resulting estimates to derive non-uniform energy decay rates for the wave equation with Neumann boundary damping under an observability hypothesis on the undamped system.

This is a joint work with Lassi Paunonen (Tampere University) and David Seifert (Newcastle University).