# Seminar on Control Theory at Fukuoka

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@ ACROS Fukuoka

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13:30-14:30

## Assessing Stability for Coupled ODE-PDE Systems Using IQC Framework

Sara Callegari (LAAS-CNRS, France)

**Abstract:** This talk focuses on the stability analysis of ODE systems coupled with PDEs, like the heat equation, and the role of its boundary conditions. The complexity lies in addressing the PDE's infinite-dimensional nature and precisely accounting for the dynamics at its boundaries. By combining Integral Quadratic Constraints with projection methods, we derive Linear Matrix Inequality conditions that make the stability analysis more tractable.

15:00-16:00

## Analysis and Control of Epidemic Spread and Innovation Adoption

Martina Alutto (CNR-IEIIT, Italy)

**Abstract:** Mathematical models of epidemics are crucial for understanding disease dynamics and informing public health strategies. In this talk, I will present a network-based extension of the classical SIR epidemic model, capturing heterogeneous interactions among multiple subpopulations. I will show how such models can exhibit complex behaviors, including multimodal infection curves. In particular, I will discuss the role of rank-1 interaction matrices and derive explicit conditions ensuring the occurrence of multiple infection peaks. I will then introduce behavioral feedback mechanisms, where the transmission rate evolves in response to the epidemic state, highlighting their impact on both transient and long-term dynamics.

This framework allows for a more realistic representation of adaptive social behavior, and I will describe results obtained both in single-population and network settings. I will also discuss related work in optimal control, and conclude with ongoing research on adoption-opinion models for sustainable innovations.

16:30-17:30

**Extraction of Destabilizing Nonlinear Operators in Absolute Stability Analysis via IQC-Based Dual LMIs**

**Hibiki Gyotoku (Kyushu Univ., Japan)**

**Abstract:** In this lecture, we talk about the absolute stability analysis problem of both continuous-time and discrete-time feedback systems comprising LTI systems and nonlinearities that are slope-restricted and repeated. By using O'Shea-Zames-Falb multipliers in the framework of Integral Quadratic Constraints (IQCs), we can obtain linear matrix inequality (LMI) conditions to ensure the absolute stability. However since these conditions are generally sufficient, if LMIs turn out to be numerically infeasible, then we can conclude nothing about the absolute stability. To address such problems, we consider the dual of IQC-based LMIs that are feasible if and only if the (primal) LMIs are infeasible. As a result, we show that if the dual solution satisfies a certain rank condition, then we can determine both a destabilizing slope-restricted nonlinearity and a non-zero equilibrium point, thereby proving that the target system is not absolutely stable.