Control Engineering for Sustainable Technical Processes

This course starts with an introduction to the concept of control and its pivotal role in enhancing the sustainability of technical processes. It introduces the mathematics that help represent physical systems with numerical models, which are instrumental in describing the input-output behavior of systems. We then delve into the application of the Laplace transform, a powerful tool that enables us to derive transfer functions, simplifying the analysis of complex systems. In the second segment of this lecture series, we shift our focus towards feedback loops and the art of designing controllers for simple systems. These controllers can play a significant role in improving the sustainability of technical processes. The course explores the delicate balance of controller design, considering multiple objectives such as precision, speed, damping level, disturbance suppression, and guidance behavior. Practical examples in the software package Matlab/Simulink accompany the theoretical aspects, enabling students to directly apply their acquired knowledge and implement it in simple software code.

Detailed class Setup:

This course is structured to provide a comprehensive understanding of control theory and its role in fostering a sustainable future. The class is organized as follows:

1. Introduction to Control for Sustainability:
    - Delve into the fundamental concepts of control engineering with a particular emphasis on its contributions to sustainability.
2. System Dynamics in Time and Laplace Domains:
    - Explore the dynamics of systems, both in the time domain and through the powerful Laplace domain, which simplifies analysis.
3. Feedback Control Loops and PID Controllers:
    - Grasp the essential idea of feedback control loops and dive into the workings of the Proportional-Integral-Derivative (PID) controller.
4. Model-Based PID Control Design Strategies:
    - Learn and apply strategies for designing PID controllers based on system models to achieve optimal control.

Course Highlights:

- The course includes real-world examples drawn from the aerospace industry, including aircraft and satellites, as well as energy systems like wind turbines. These practical examples enrich the learning experience by demonstrating the real-world application of control engineering.
- Extensive laboratory sessions in the second week are an integral part of the course. Students will have the opportunity to work with Matlab/Simulink, both in soft- and hardware

examples. This hands-on experience allows students to apply and thereby strengthen the knowledge they have acquired and gain practical proficiency in control theory.

Prerequisites

Minimum: Physics including Newton's laws and thermal analysis, Math: Calculus 1, derivatives, and integrals

Preferred: Differential equations, Engineering Dynamics, Engineering Thermodynamics, Computer programming