Control System Design

Lecture 14

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Elective Course in Mechatronics Engineering
Credits (2/2/3)

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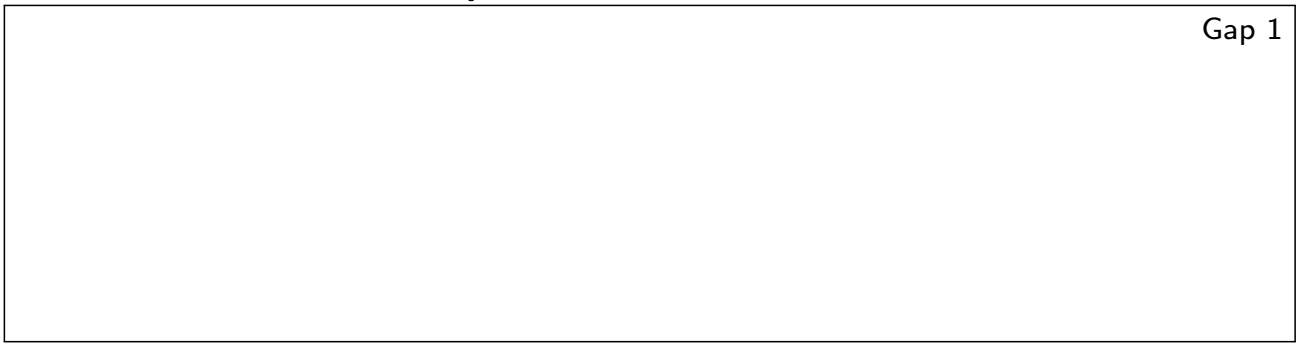
Cascade Control: Basic Setup

Cascaded Feedback Loop



Assumptions

- Additional plant variable y' after the disturbance is measurable

Idea

- Attenuate disturbance d in an inner feedback loop with the inner output y' before it arrives at the actual output y
- Perform feedback control for the output y in the outer loop

Cascade Control: Transfer Functions

Inner Loop

$$\frac{Y'(s)}{U_1(s)} = T_i(s) = \frac{C_2(s)G_1(s)G_2(s)}{1 + C_2(s)G_1(s)G_2(s)}$$
$$\frac{Y'(s)}{D(s)} = S_i(s) = \frac{G_2(s)}{1 + C_2(s)G_1(s)G_2(s)}$$

Outer Loop

$$\frac{Y(s)}{D(s)} = -\frac{S_i(s)G_3(s)}{1 + C_1(s)G_3(s)T_i(s)}$$

$\Rightarrow$ The disturbance d is pre-compensated by the inner feedback loop, whereby the inner loop should be considerably faster than the outer loop!

$$\frac{Y(s)}{R(s)} = \frac{C_1(s)T_i(s)G_3(s)}{1 + C_1(s)T_i(s)G_3(s)}$$

Cascade Control: Procedure

Controller Design for the inner loop

Gap 2

Controller Design for the Outer Loop

Gap 3

Cascade Control: DC Motor Example

Example

Gap 4

Cascade Control: DC Motor Example

Outer Loop

Gap 5