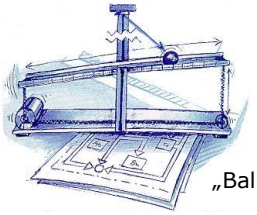
Controlled Systems


„Ball rocker"

Introduction

In control engineering, a controlled system is primarily characterised by its **dynamic behaviour** which also determines the scope *[=Aufwand]* and quality required to solve a control task. Frequently, the so-called **step response** of the controlled system is used to reflect this dynamic behaviour.
The step response reveals how the **controlled variable x** reacts to a change in the **manipulated variable y**. This is determined by measuring the controlled variable after a step change in the manipulated variable. Depending on the resulting dynamic behaviour, the controlled systems can be classified as follows:

- **P controlled systems** (proportional control action)
- **I controlled systems** (integral control action)
- **Controlled systems with dead time**
- **Controlled systems with energy storing components** (first-, second- or higher-order)

The different controlled systems will be discussed in the following task in more detail. We must differentiate between controlled systems in which a new **equilibrium** *[=Gleichgewichtszustand]* is established after a disturbance or change in the manipulated variable and systems with a continuously changing controlled variable:

- **Systems with self-regulation** only change until a new stable output value is reached.
- **Systems without self-regulation** do not reach a new state of equilibrium.

Systems without self-regulation require closed-loop control, because the manipulated variable must become zero as soon as the controlled variable reaches the required equilibrium. Practical experience shows that systems with self-regulation are often much easier to control than systems without self-regulation. Systems without self-regulation have a tendency to oscillate, i.e. they tend to be more unstable.

Learning objectives

By the end of this learning sequence you will …

- … be able to name the different controlled systems.
- … understand the characteristics of the different controlled systems.
- … be familiar with examples that represent the controlled systems.

Optional homework

Create your own vocab cards and learn the new vocabulary.

Task

Work out a brief **presentation in English** on one of the controlled systems listed in the table below.

no.	Controlled systems	Students
1	Pure P controlled systems	Nik Irniger, Miguel Schnyder, Ivo Wander
2	P controlled systems with energy storing components (first-order)	Jonas Binder, Patrick Blickenstorfer, Dimitri Huber
3	P controlled systems with energy storing components (second-order)	Mauro Ballarino, Marko Ilic, Ismael Waber
4	P controlled systems with energy storing components (second-order) and oscillating character	Laurent Misini, Jérôme Viel, Jeremiah Waber
5	P controlled systems with energy storing components (higher-order)	Marc Hochuli, Nico Müller, Remo Peterhans
6	Controlled systems with dead time	Simon Möri, Jacqueline Reichmuth, Luca Schäfli
7	I controlled systems	Simon Enarson, Hannah Lomax, Noé Meier, Robin Müller

Requirements

+ Explain the main characteristics of the controlled system in accordance with the document „Regelstrecken".
+ Show one practical example that represents the controlled system. Refer to the document „Regelstrecken".
+ Answer the following question: Is your controlled system a system with or without self-regulation and why? Refer to the introduction of this document.
+ Use as many words as possible from the word bank given on the next page.
+ Use diagrams, figures and pictures in your presentation.
+ Your presentation must be ready by next week's lesson.
+ Duration of the presentation: **10 minutes**
+ Before your presentation, upload the PowerPoint slides on Moodle.

Vocabulary list

The vocabulary required for the presentation is given below.

English:	German:
Buffer, reservoir	Speicher
Controllability	Regelbarkeit
Controllable	regelbar
Controlled systems	Regelstrecken
Controlled systems with energy storing components	Strecken mit Energiespeichern
Controller parameter	Reglerparameter
Damping	Dämpfung
Dead time	Totzeit
Dynamic	dynamisch
Final value	Endwert
First-order delay element	Verzögerungsglied erster Ordnung
Gain factor	Verstärkungsfaktor
Gear wheel	Zahnrad
Higher-order delay element	Verzögerungsglied höherer Ordnung
I controlled systems	I-Regelstrecken
I element / I-function / I-block	I-Glied
Integral-action coefficient	Integrierbeiwert
Integral-action time	Integrierzeit
Integral control action	integrales Verhalten
Oscillatory	schwingfähig
P controlled systems	P-Regelstrecken
P element	P-Glied
Process lag T_u	Verzugszeit T_u
Process reaction rate T_g	Ausgleichszeit T_g
Proportional control action	Proportionales Verhalten
Proportional element	Proportionalglied
Proportional-action coefficient	Proportionalbeiwert
PT_n element/ PT_n-function/ PT_n-block	PT_n-Glied
PT_t element/ PT_t-function/ PT_t-block	PT_t-Glied
PT_1 element/ PT_1-function/ PT_1-block	PT_1-Glied
Reversing tangent	Wendetangente
Second-order delay element	Verzögerungsglied zweiter Ordnung
Static	statisch
Step function	Sprungfunktion
Step response	Sprungantwort
Storage element	Speicherglied
Systems with self-regulation	Strecken mit Ausgleich
Systems without self-regulation	Strecken ohne Ausgleich
Time constant	Zeitkonstante
Turning point	Wendepunkt
without time delay	verzögerungsfrei