Ongoing Lectures Collection

CS241

Linear Control Systems

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February 12, 2020

GitHub Repository
https://github.com/EngAhmedWaleed/Lectures-Collection/tree/control

Preface

Using LaTeX, at least a hope that this work continues exists. I don't have much else to say, so I will just insert some blind text. Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

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1 First Lecture

1.1 Introduction

Analysis of linear continuous system analysis of a system means simply check the goodness of its measure of performance. Analysis could be done in two different ways:

- In the lab: by putting test input to the system and check the output how it satisfies the measure of performance.
- Using analytical techniques: which is our concern in this course.

The first step is to make a mathematical model to the system.

$$\Sigma F_x = m\ddot{x}$$
$$F - \mu\dot{x} + kx = m\ddot{x}$$
$$\therefore \boxed{F = m\ddot{x} + \mu\dot{x} + kx}$$

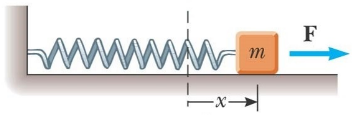


Figure 1.1: A block attached to a spring. ©

Then defining the measure of performance and study how analytically can check these measure of performance.

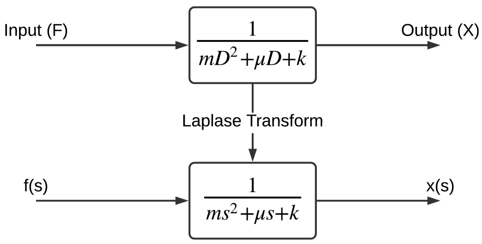


Figure 1.2: Since D is an operator (can't have a value), the transfer function is obtained by the Laplace transform of the first relation.

Transfer function ratio between Laplace transform of the output and Laplace transform of the input, assuming zero initial conditions.

1.2 Control Systems

A control system is an interconnection of components forming a system configuration that will provide a desired system response.

Open-loop control system (without feedback):

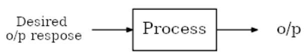


Figure 1.3: Its output does not track the input, and it is more affected by noise.

Closed-loop feedback control system (with feedback):

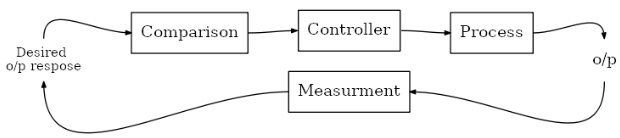


Figure 1.4: Closed loop control can improve accuracy, also the actuating signal is a function of the output.

1.3 Mathematical Model

Any linear continuous system can be represented either by a linear algebraic equation of an ordinary differential equation such as:

$$(mD^2 + \mu D + k)\, x(t) = y(t)$$

Solving the differential equation using Laplace transform assuming zero initial conditions made it possible to get the transfer function.

1.4 Block Diagram Reduction

Control systems require the arithmetic manipulation in order to obtain the overall transfer function and this is the start point for the analytical analysis of the system.

Table 1.1: Terminology

R	:	reference input / desired output response.
E	:	actuating / error signal.
G	:	control element and controlled system.
C	:	controlled variable / actual output.
H	:	feedback element.
B	:	primary feedback.
s	:	summation point.
t	:	takeoff point.

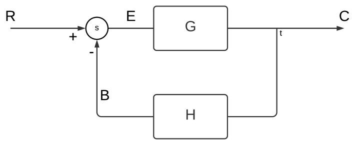
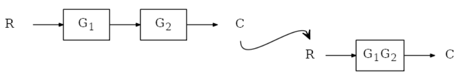
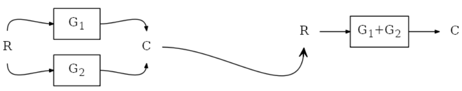


Figure 1.5: Canonical feedback loop.

Cascade connection :



Parallel connection :



Summation point :
some definition ...

Take-off point :
some definition ...

Overall transfer function (feedback loop elimination):

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Appendix

A

Table of Laplace Transforms

Def. Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.