Computerized control - Introduction

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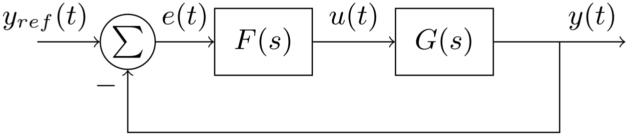
Who am I?

Who are you?

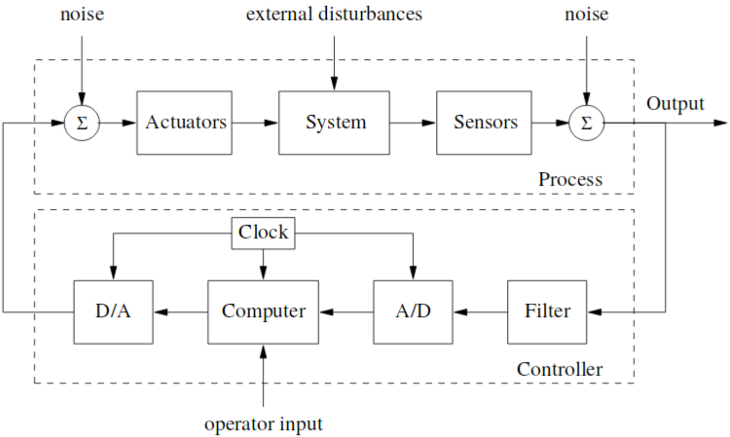
Goal of the course

To be able to analyze, design, implement and evaluate computerized product and process control systems with a focus on practical application.

Feedback control

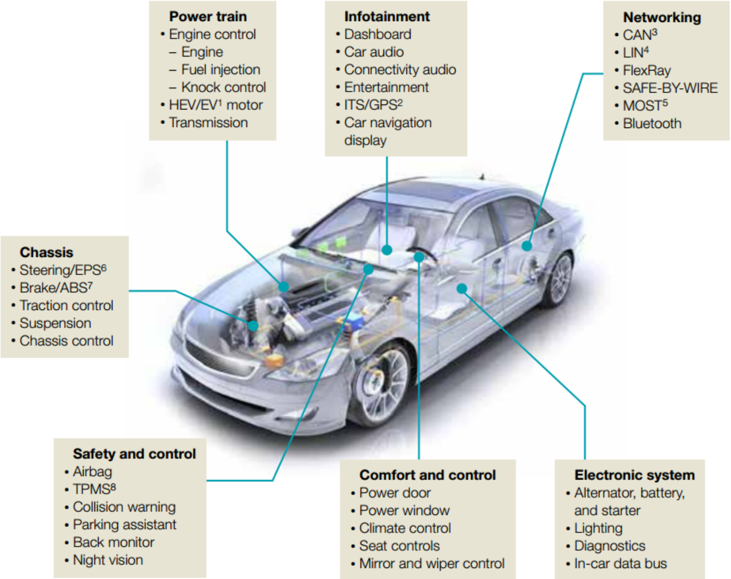


Feedback control



Why computerized control?

Computers everywhere



Two approaches to designing a discrete-time controller

1. Do design the controller in the continuous-time domain (methods from control engineering class). Then discretize the continuous-time controller.
2. Determine discrete-time model of the plant. Do design in discrete-time domain.

Example of design in the discrete time domain

Example - Hydro-power plant

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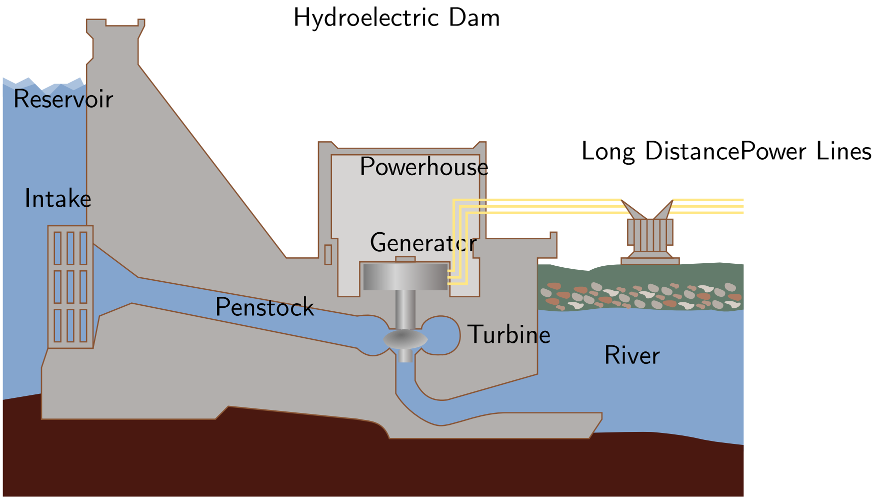
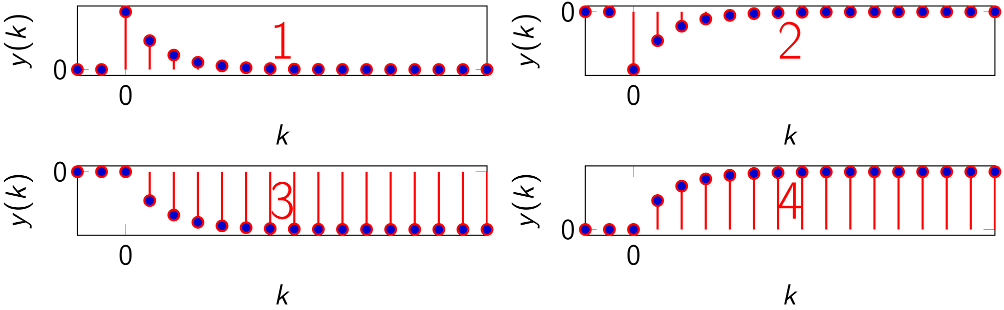


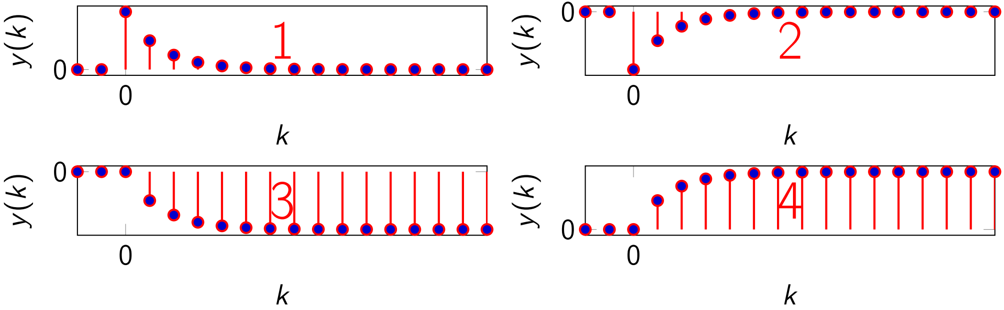
Which graph best illustrates the pulse response?

Let $h = 60$ s, $A = 1.2 \times 10^5$ m^2 and $K = 10^3$ m^2/s



Which graph best illustrates the step response?

Let $h = 60$ s, $A = 1.2 \times 10^5$ m^2 and $K = 10^3$ m^2/s



Discrete design can give better performance

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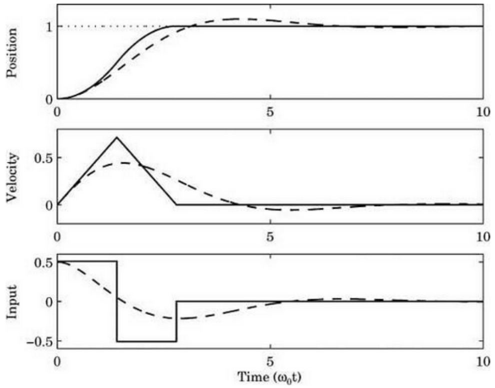


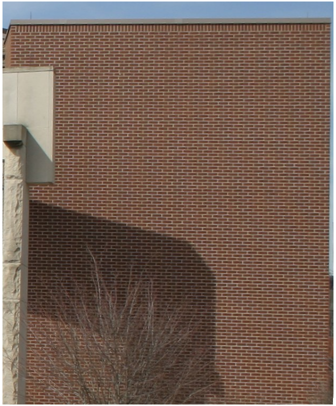
Figure 1.9 Simulation of the disk arm servo with deadbeat control (solid). The sampling period is $h = 1.4/\omega_0$. The analog controller from Example 1.2 is also shown (dashed).

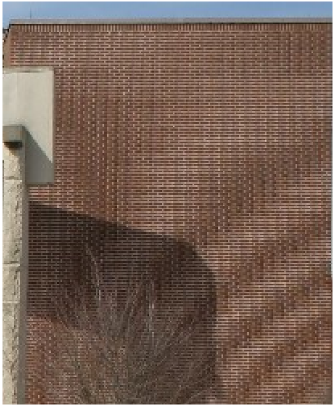
Why computerized control?

- Almost all control systems are implemented on computers/microcontrollers
- Controllers designed in continuous-time must be discretized to be implemented on a computer - What does this mean for the performance?
- Design that takes into account the discrete nature of the computer can give better performance

Challenges with computerized control

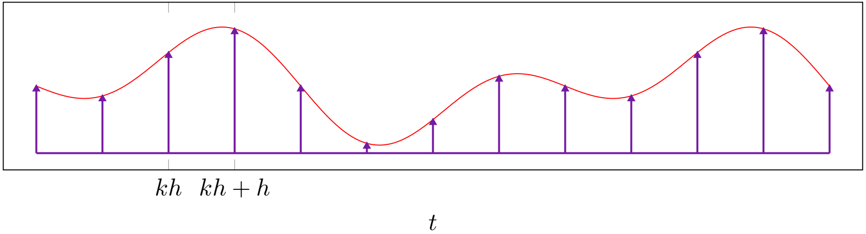
Aliasing



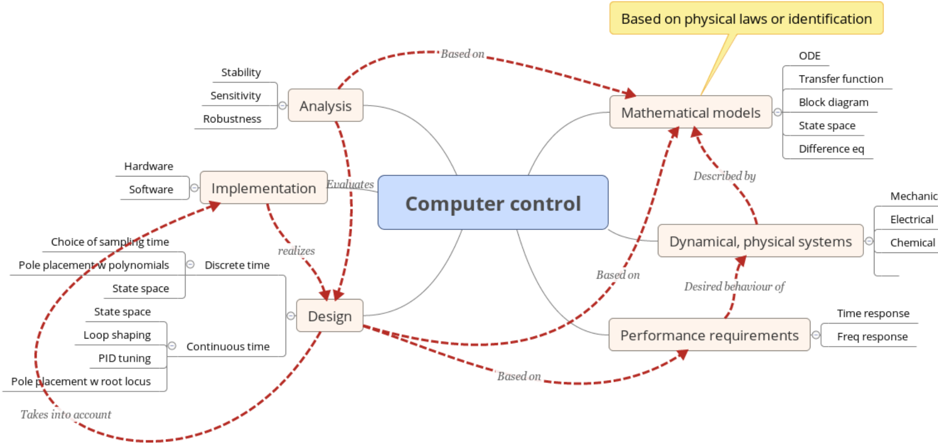


Challenges with computerized control

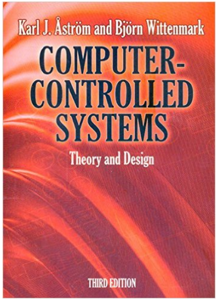
Sampling causes delay



Control concepts

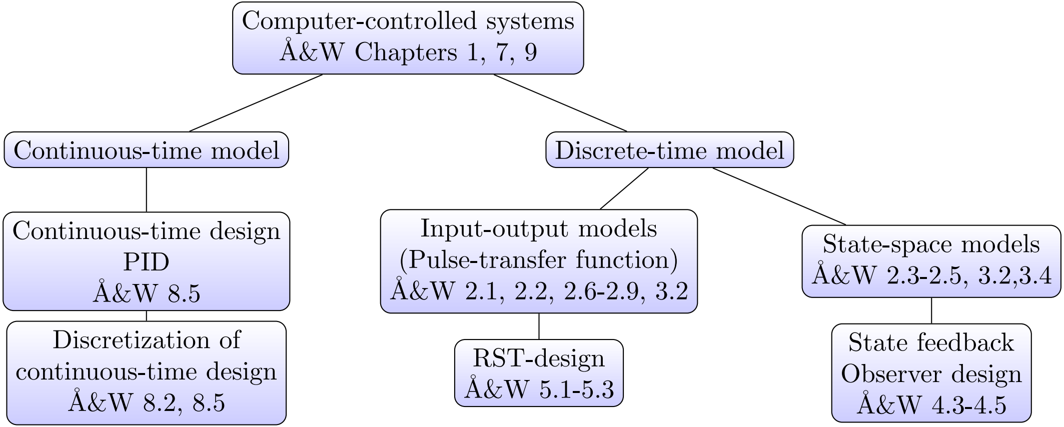


Course book



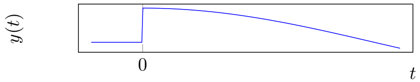
Buy ebook at Google Books (573 MXN)

Course overview



Discrete time vs continuous time

Continuous time



$y(t)$

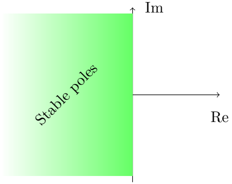
$\mathrm{p}\,y \triangleq \frac{d}{dt}y$

$(\mathrm{p}+a)y = bu \;\Leftrightarrow\; \frac{d}{dt}y + ay = bu$

$Y(s) \triangleq \mathcal{L}\{y(t)\}$

$Y(s) = G(s)U(s) = \frac{b}{s+a}U(s)$

Pole of the system: $s + a = 0 \;\Rightarrow\; s = -a$



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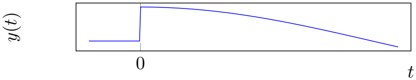

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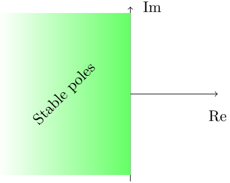
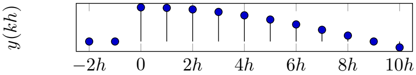


Discrete time



$y(kh)$ or $y(k)$

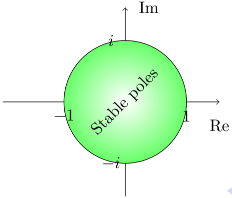
$\mathrm{q}\, y \triangleq y(kh + h)$

$(\mathrm{q} + \alpha) y = \beta u \;\Leftrightarrow\; y(k+1) + \alpha y(k) = \beta u(k)$

$Y(z) \triangleq \mathcal{Z}\{y(kh)\}$

$Y(z) = H(z)U(z) = \frac{\beta}{z+\alpha} U(z)$

Pole of the system: $z + \alpha = 0 \;\Rightarrow\; z = -\alpha$



How we will work

Prepare, prepare, prepare for classes:

1. Read text material and watch video
2. Solve quizz (test) on Canvas (up to 100p, accounts for 1% of final grade)

In class:

1. Review of material
2. Work with concepts
3. Problem solving
4. Summarize

Homework

- About every second week
- Solved in groups of 2 (except first hw which is individual), handed in on Canvas
- Each homework accounts for 4% of final grade (except first hw which is 2%)

Project

- Implement controller on arduino, accounts for 10% of final grade
- Groups of 4 (self-elected)
- Partial reports (2×15p)
- Final report (30p)
- Demonstrate working open-loop setup (10p)
- Demonstrate controller design and working closed-loop system (20p)
- Individual journal (10p)

Examination

- Quizzes 10%
- Homework 18%
- Project 10%
- 2 partial exams (1.5hrs) 36%
- Final exam (3hrs) 26%

Coming up

- Homework 1: Repetition of stuff from control engineering. On Canvas.
- See preparation instructions for next week on Canvas