PHILIPS CTT Hogeschool van Utrecht

Systeem en Regeltechniek
FMT / Mechatronica

Deel 6: Extra regeltechniek
Oefening: Setpoints / feedforward tuning / digital controller delay

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Cursus Systeem en Regeltechniek
Overzicht

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	Blok 3.	De regelaar als veer-demper combinatie
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	Blok 5.	Basisconcepten in de regeltheorie
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	Blok 14.	Terugblik / Evaluatie

20-sim exercise

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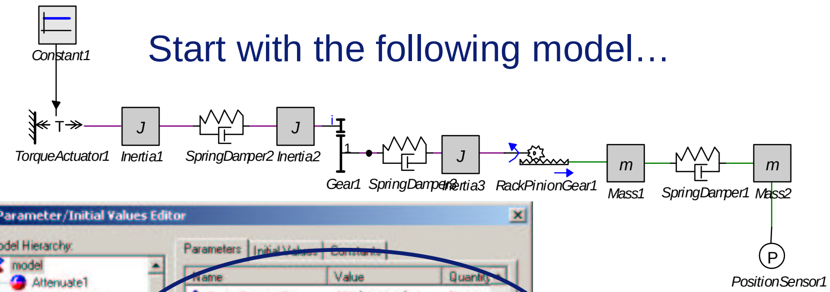
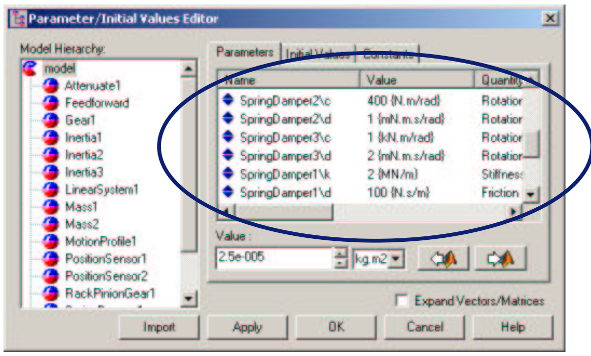
Exercise Setpoint

Start with the following model…





Check parameter settings!

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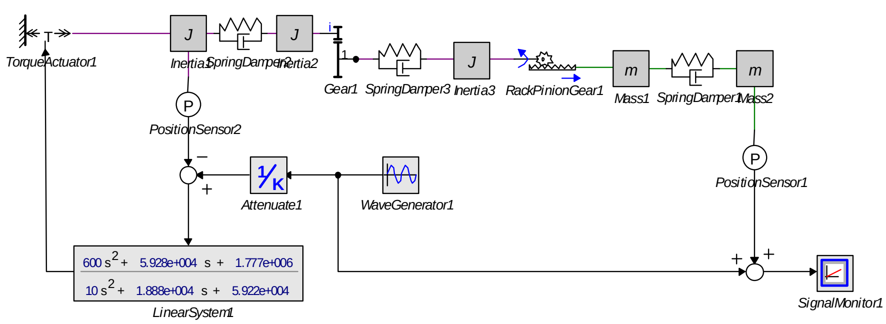
Exercise Setpoint

Build a closed loop system according to the following scheme (K=0.003)…



Hint: use the PID controller settings of previous exercise

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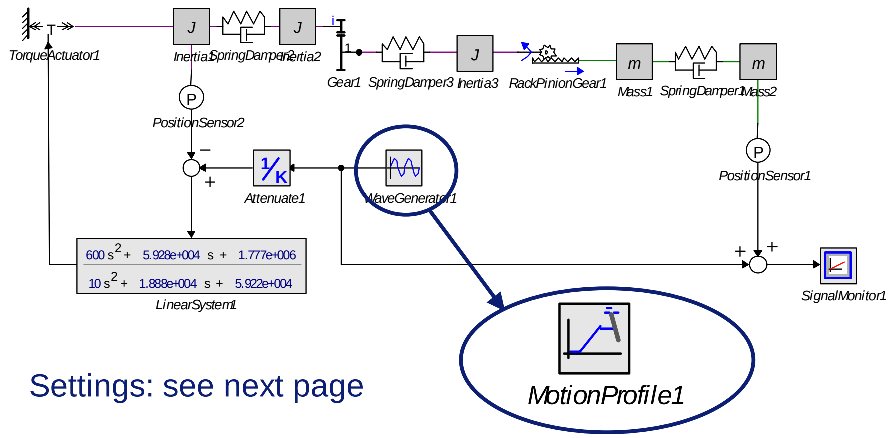
Exercise Setpoint

Replace the wave generator by a motion profile generator (wizard)



Settings: see next page

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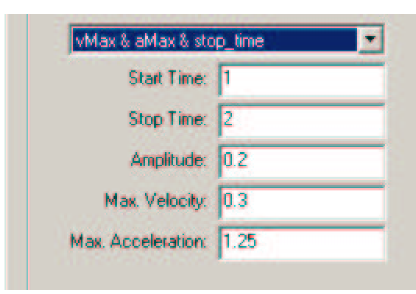
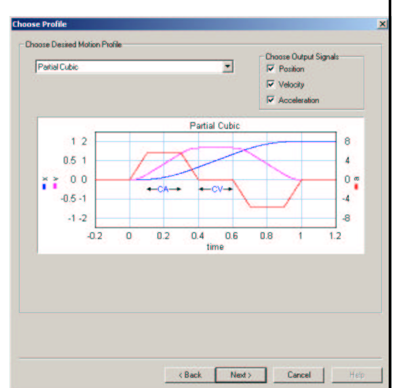
Exercise Setpoint

Settings in Motion Profile Wizard:

- Desired motion type: Step
- Desired motion profile: Partial Cubic
- Initial parameter settings:





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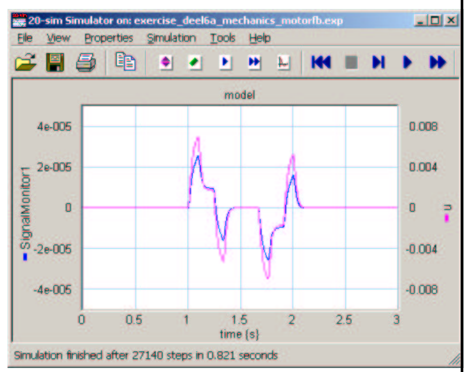
Exercise Setpoint Assignments / Questions

- Simulate time response and check:
  - Setpoint profile
  - Controller input
  - Signal Monitor output
- In which part of the setpoint does the error occur? Why?
- Decrease the max. acceleration to 1 m/s^2 What happens?



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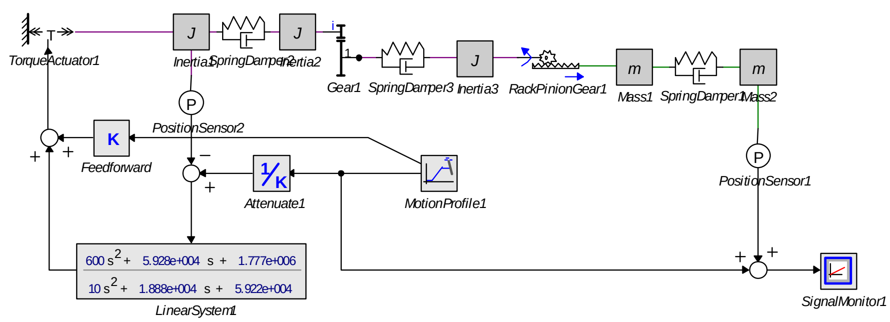
Exercise Feedforward tuning

Add a mass/inertia feedforward gain:



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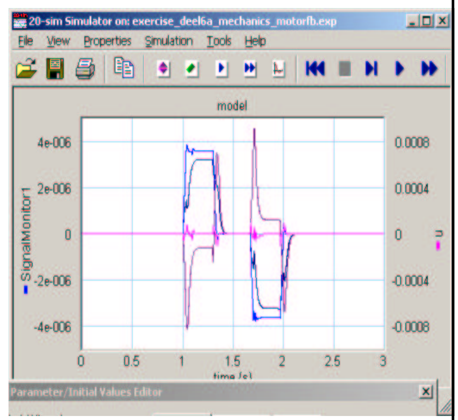
Exercise Feedforward Tuning
Assignments / Questions

- Adjust feedforward gain and simulate time responses and check:
  - Controller input
  - Signal Monitor output
- For which feedforward gain is the servo-error minimal?
- Explain why the real error (Signal Monitor) is nonzero



w = 1 rad/s: 78 dB

“M_{red} = 0.125 gr” / 0.003 => K=0.042

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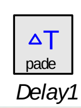
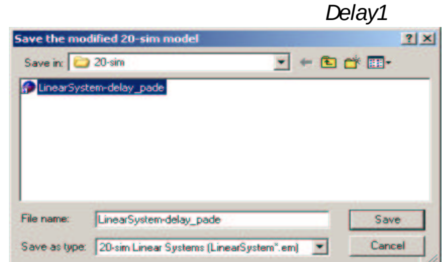
Exercise Digital Controller Delay

- Assume that the controller is digitally implemented with a sample frequency of 5 kHz; what is the effective delay time?
- Build model that approximates the delay (via Padé):



- Linearise this model
- Save the linearised model as a linear system:



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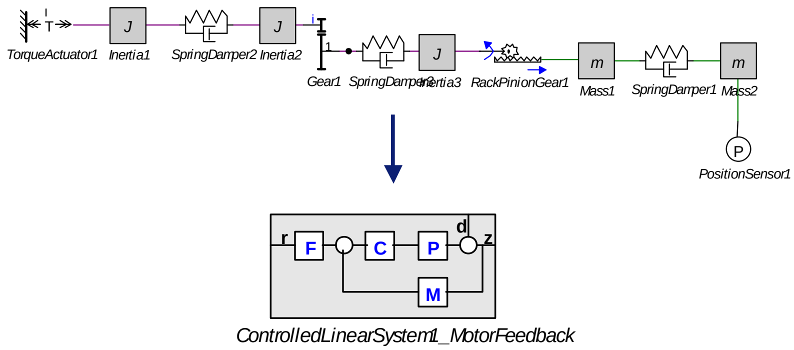
Exercise Digital Controller Delay

- Make a controlled linear system description of the mechanical system:



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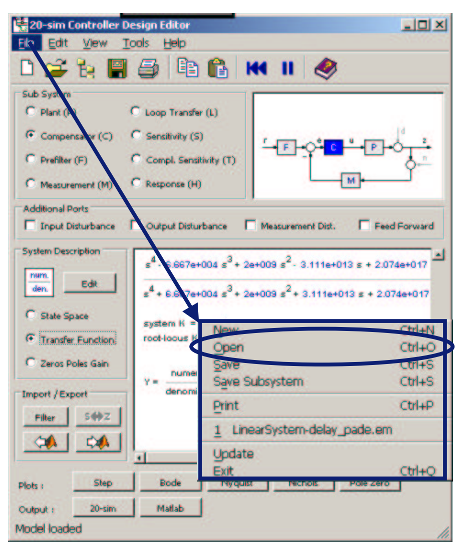
Exercise Digital Controller Delay

- Start controller design by opening the LinearSystem model of the delay
- Add PID filter and tune parameters
- Retune iteratively to achieve maximum bandwidth…



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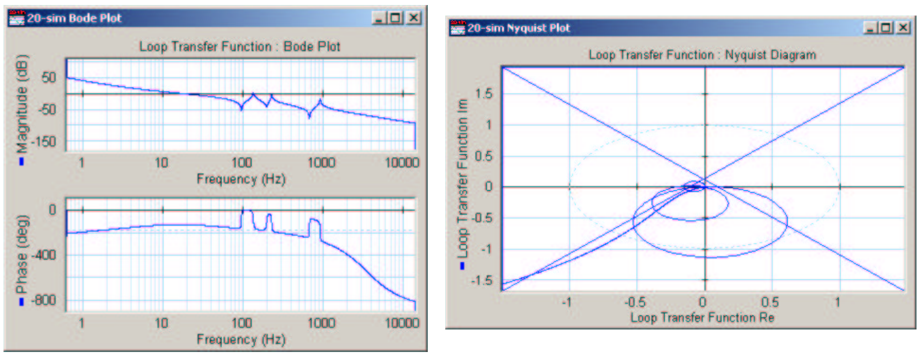
Exercise Digital Controller Delay

- Look at the Loop Transfer Function: what does the delay do?



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Exercise Digital Controller Delay Additional assignments / questions

- Which resonance frequency of the system is causing stability problems?
- What bandwidth is achievable with PID?
- What does this mean for the disturbance suppression at 3 Hz?
- How can the stability problem be reduced by using additional filters?
- What is the response on a motion profile? Should the feedforward tuning be changed?

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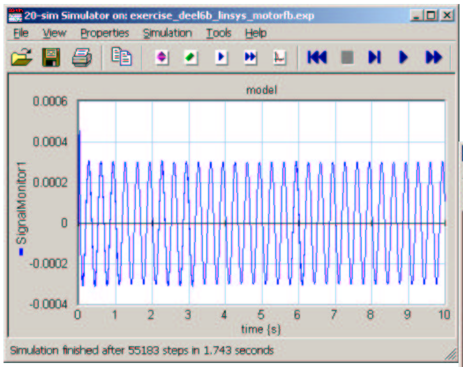
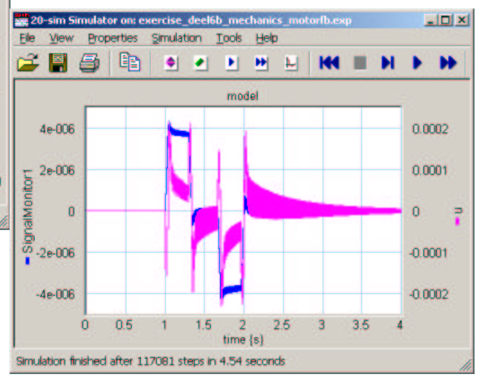
Exercise Digital Controller Delay
Some results



Disturbance suppression

Servo tracking with feedforward



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