Homework 3 in EL2450 Hybrid and Embedded Control Systems

First name1 Last name1
person number
email

First name2 Last name2
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email

First name3 Last name3
person number
email

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email

February 26, 2016

Instructions and Help

Please remove this part and the sample references before submitting your homework.

Read the general homework instructions available on the course homepage before starting to write the report.

Here are some additional guidelines how to write a homework report.

- Fill in name and personal number of all group members.
- Do not copy the task descriptions and use the structure below.
- Do not include code unless the task explicitly states so.
- Motivate your answers well and how you derived them, but be concise.
- The number of points is not necessarily related to much you need to write for task.
- Put references in the end if any.
- Do not include plots from the Simulink scope (color on black background) but export the data to Matlab for plotting.
- Include graphics directly in the text and not in a Figure environment, as you normally would. That makes it easier to correct the report.
- There is plenty of material available how to use Latex. Use a search engine of your choice to learn more.

Here are some examples how to use Latex:

- An equation with a reference (1) to it

$$\dot{x} = \frac{3}{4}x. \tag{1}$$

- A multi-line equations with a reference to it

$$\begin{aligned} \hat{x} &= x - y \\ \alpha &= x + \gamma. \end{aligned}$$

- An equation in text: $\Phi = \int\limits_0^h \mathrm{e}^{A\tau} d\tau$.

- An image

- A table

-2.46	0	-1.73	0
0	-2.553	0	2.774
0	6.172	-10	7.333
1.767	-0.357	5.714	-6.074

- A citation [2]

- Display something exactly as it is written: `\frac{1}{2}_`

- Basic formating: **bold**, *italics*, `typewriter`

Task 1

Since

$$\begin{aligned} u_\omega &= \frac{u_r + u_l}{2} \\ u_\Psi &= u_r - u_l \end{aligned}$$

$$\Leftrightarrow$$

$$\begin{aligned} u_l &= u_\omega - \frac{u_\Psi}{2} \\ u_r &= u_\omega + \frac{u_\Psi}{2} \end{aligned}$$

Task 2

Task 3

Task 4

Task 5

Task 6

Task 7

Task 8

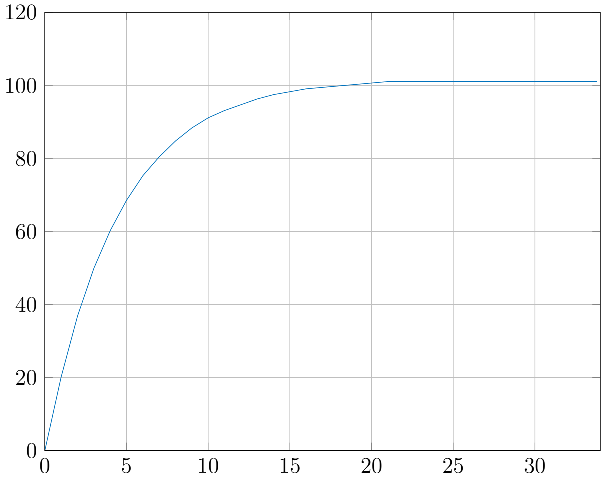

Figure 1: The orientation of the robot over time for $K_{\Psi} = 0.1K_{\psi,max}$.
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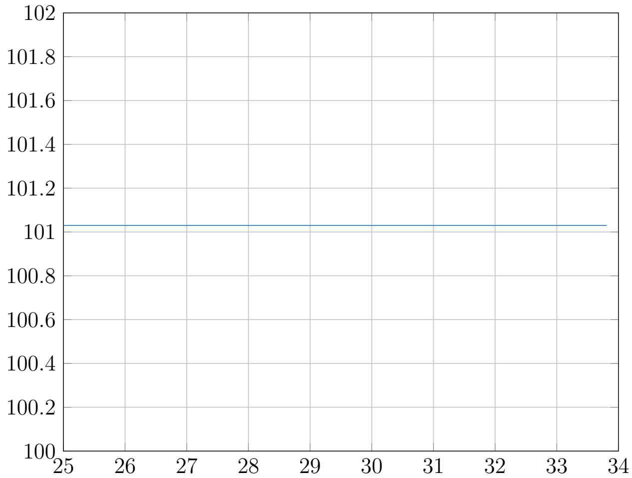

Figure 2: The steady state orientation of the robot for $K_{\Psi} = 0.1K_{\psi,max}$.

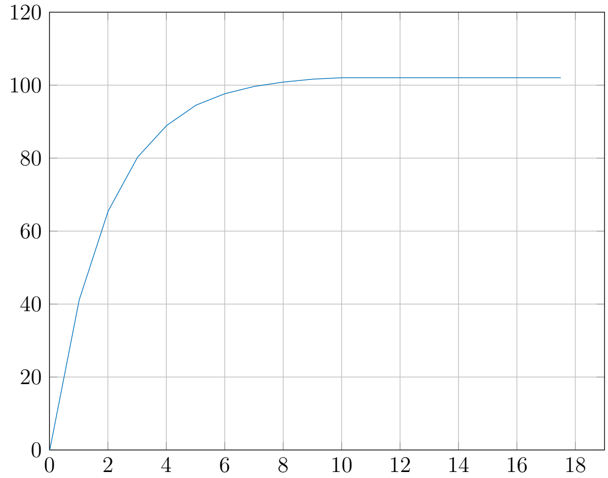

Figure 3: The orientation of the robot over time for $K_\Psi = 0.2K_{\psi,max}$.

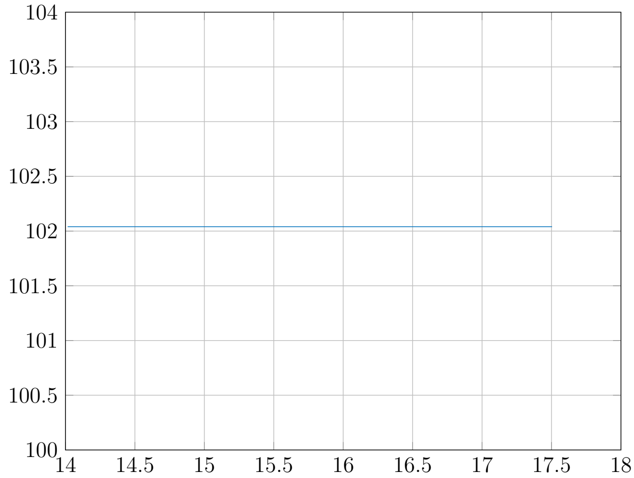

Figure 4: The steady state orientation of the robot for $K_\Psi = 0.2K_{\psi,max}$.

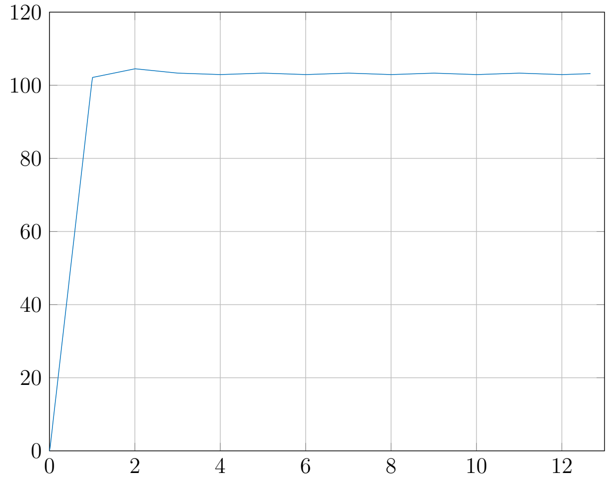

Figure 5: The orientation of the robot over time for $K_\Psi = 0.5K_{\psi,max}$.

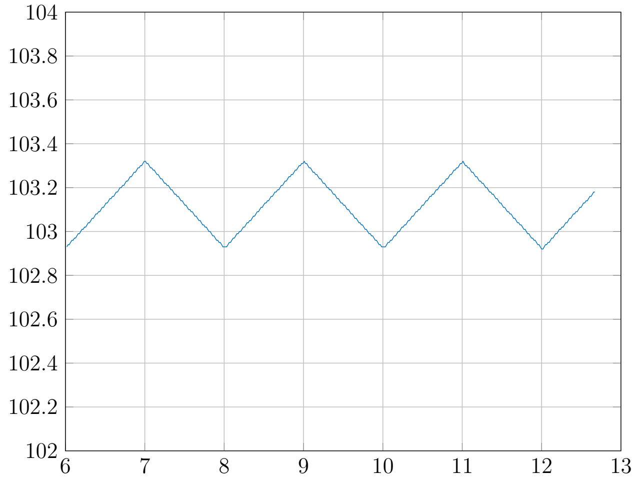

Figure 6: The steady state orientation of the robot for $K_\Psi = 0.5K_{\psi,max}$.

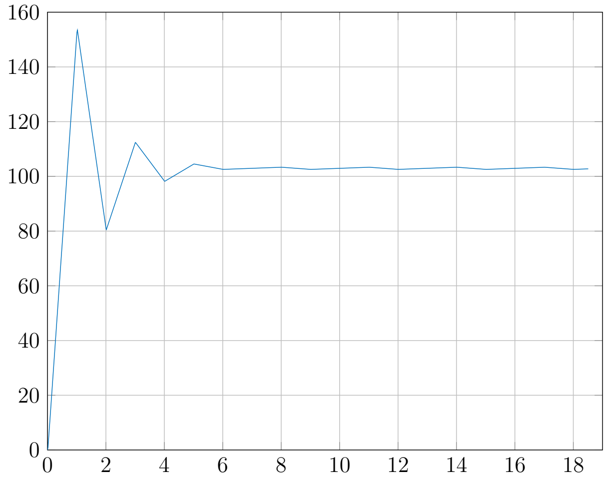

Figure 7: The orientation of the robot over time for $K_{\Psi} = 0.75K_{\psi,max}$.

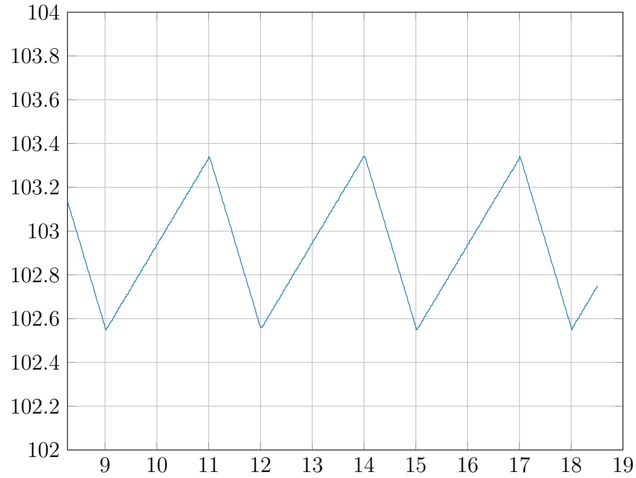

Figure 8: The steady state orientation of the robot for $K_{\Psi} = 0.75K_{\psi,max}$.

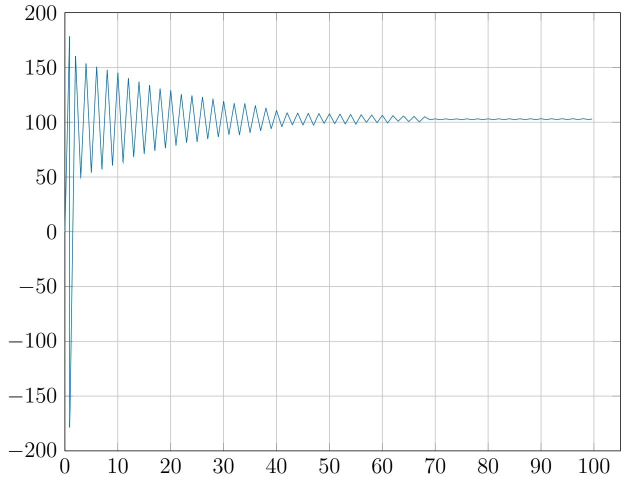

Figure 9: The orientation of the robot over time for $K_{\Psi} = K_{\psi,max}$. This is the upper limit value of K_{Ψ} before the system becomes unstable.

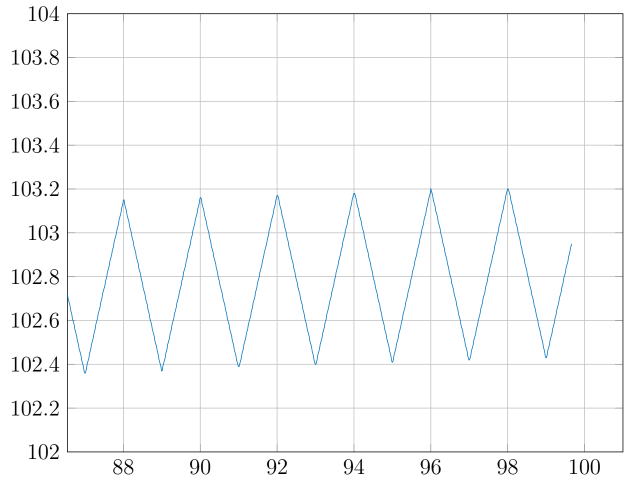

Figure 10: The steady state orientation of the robot for $K_{\Psi} = K_{\psi,max}$.

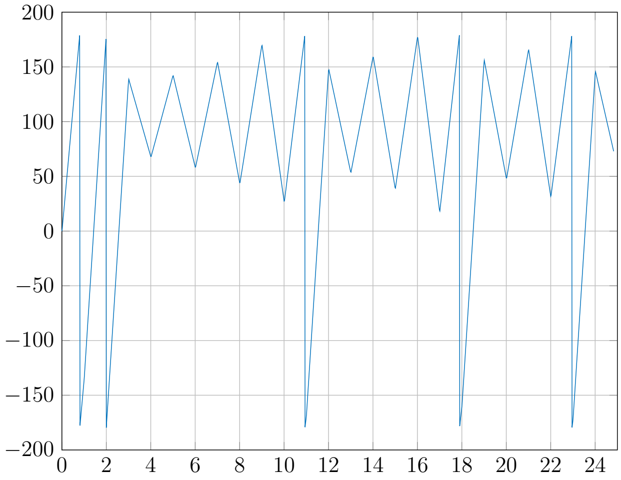

Figure 11: The orientation of the robot over time for $K_{\Psi} = K_{\psi,max} + 1$. The system is indeed unstable.

Task 9

Task 10

Task 11

Task 12

Task 13

Task 14

Task 15

Task 16

Task 17

Task 18

Task 19

Task 20

Task 21

Task 22

References

[1] Hassan K Khalil. *Nonlinear systems.* Prentice Hall, Upper Saddle river, 3. edition, 2002. ISBN 0-13-067389-7.

[2] Tobias Oetiker, Hubert Partl, Irene Hyna, and Elisabeth Schlegl. *The Not So Short Introduction to LaTeX 2ε.* Oetiker, OETIKER+PARTNER AG, Aarweg 15, 4600 Olten, Switzerland, 2008. http://www.ctan.org/info/lshort/.

[3] Shankar Sastry. *Nonlinear systems: analysis, stability, and control*, volume 10. Springer, New York, N.Y., 1999. ISBN 0-387-98513-1.