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Automatisch generierte BeschreibungAutonomous Systems – Path Planning and Control

Lab Project Documentation (2.5 ECTS)

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| Term: | Winter term 2021/22 |

Inhalt

[1 Exercise 5 - Vehicle Dynamics 3](#_Toc93412282)

[1.1 Exercise 5.1 Longitudinal dynamic model 3](#_Toc93412283)

[1.1.1 Exercise 5.1 b) Calculation of the parameters 3](#_Toc93412284)

[1.1.2 Exercise 5.1 c) Calculation of the transfer function 3](#_Toc93412285)

[1.1.3 Exercise 5.1 d) Bode plot and step response 4](#_Toc93412286)

[1.2 Exercise 5.2 vehicle simulation 5](#_Toc93412287)

[1.2.1 Exercise 5.2 b) Simulink model of the vehicle 5](#_Toc93412288)

[1.2.2 Exercise 5.2 c) Test 5](#_Toc93412289)

[1.3 Exercise 6.1 vehicle simulation 10](#_Toc93412290)

[1.3.1 Exercise 6.1 a) Parameter calculation 10](#_Toc93412291)

[1.3.2 Exercise 6.1 b) Bode plot of G0(s) 12](#_Toc93412292)

[1.3.3 Exercise 6.1 c) Step Response of Gw(s) 13](#_Toc93412293)

[1.3.4 Exercise 6.1 d) discretization 13](#_Toc93412294)

[1.4 Exercise 6.2 Speed Control simulation 14](#_Toc93412295)

[1.5 Exercise 8.1 Path definition of straight lines 15](#_Toc93412296)

[1.5.1 Exercise 8.1 a) Derivation of parameterized curve definition 15](#_Toc93412297)

[1.5.2 Exercise 8.1 b) Calculation of curvature, tangent vector and normal vector 15](#_Toc93412298)

[1.6 Exercise 8.2 MODBAS CAR Function for Clothoids (not required for 2.5 ECTS) 16](#_Toc93412299)

[1.6.1 See the following matlab-files: 16](#_Toc93412300)

[1.7 Exercise 9.1 Path Following Controller 17](#_Toc93412301)

[1.7.1 Yaw-angle diagram 17](#_Toc93412302)

# Exercise 5 - Vehicle Dynamics

## Exercise 5.1 Longitudinal dynamic model

### Exercise 5.1 b) Calculation of the parameters

The following formula was given as a solution to exercise 5) a):

with the starting condition:

calculation of

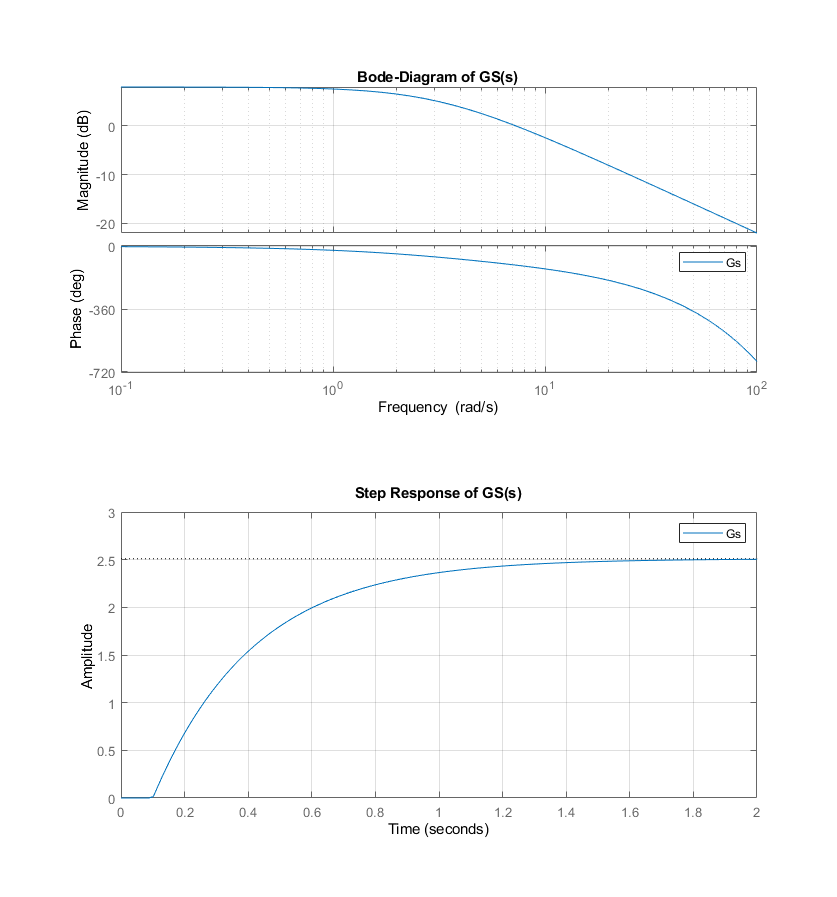
### Exercise 5.1 c) Calculation of the transfer function

With the parameters calculated in 5) b) the transfer function can be calculated as follows.

### Exercise 5.1 d) Bode plot and step response

See the following files:

* ex5\_1.m



## Exercise 5.2 vehicle simulation

### Exercise 5.2 b) Simulink model of the vehicle

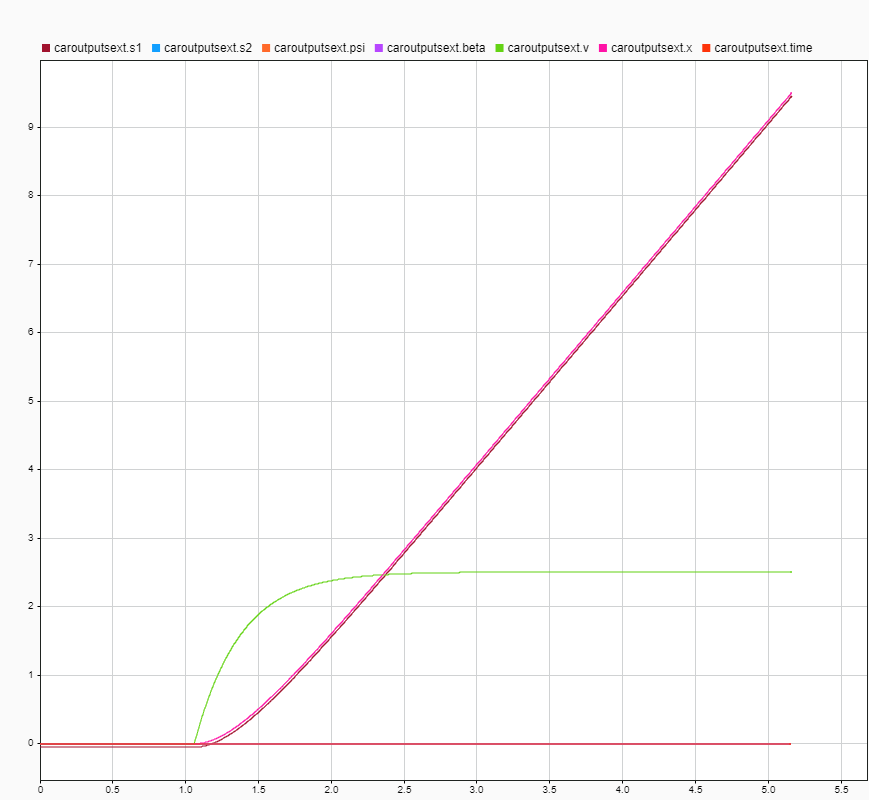
See the following files:

* s6\_template.slx (created with version R2020b)
* s6\_template\_2019a.slx (converted to version R2019a)

### Exercise 5.2 c) Test

Below we inserted a few diagrams with different parameters for the pedals, steering and command

1. CarInputsCommandForward, pedals = 1, δ = 0

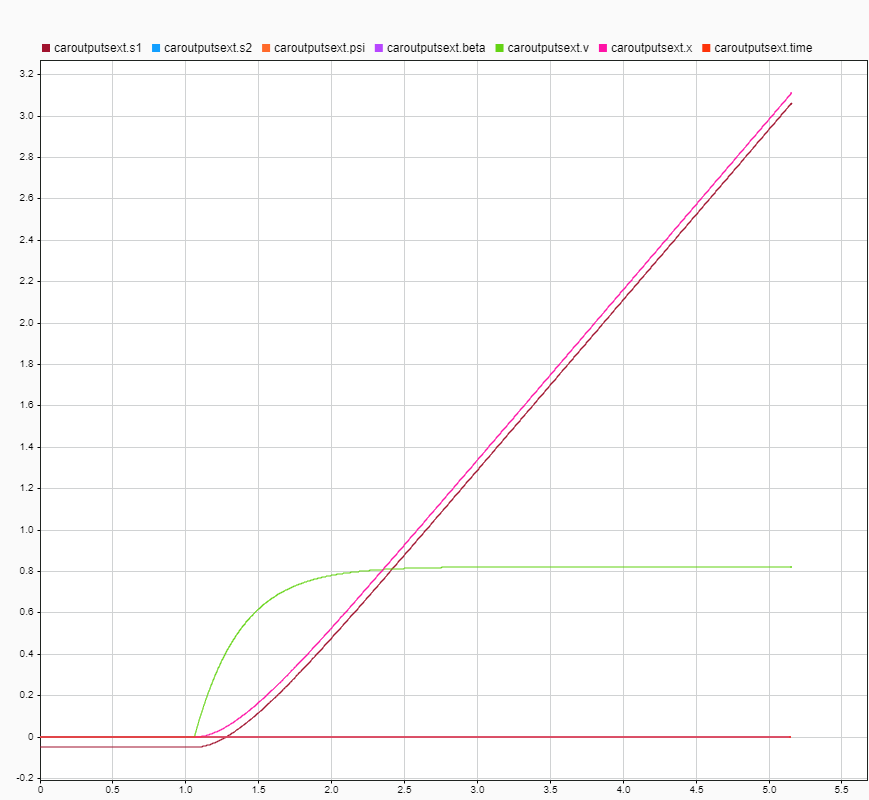


t [s]

speed [m/s]

yaw angle [rad]

1. CarInputsCommandSlow, pedals = 1, δ = 0

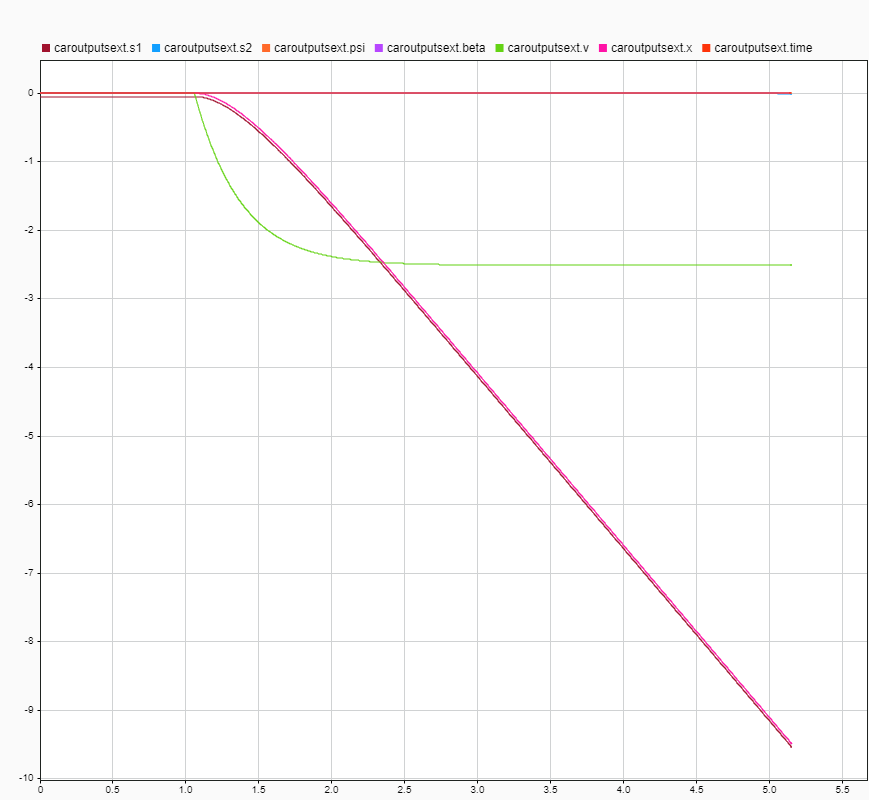


t [s]

speed [m/s]

yaw angle [rad]

1. CarInputsCommandReverse, pedals = -1, δ = 0

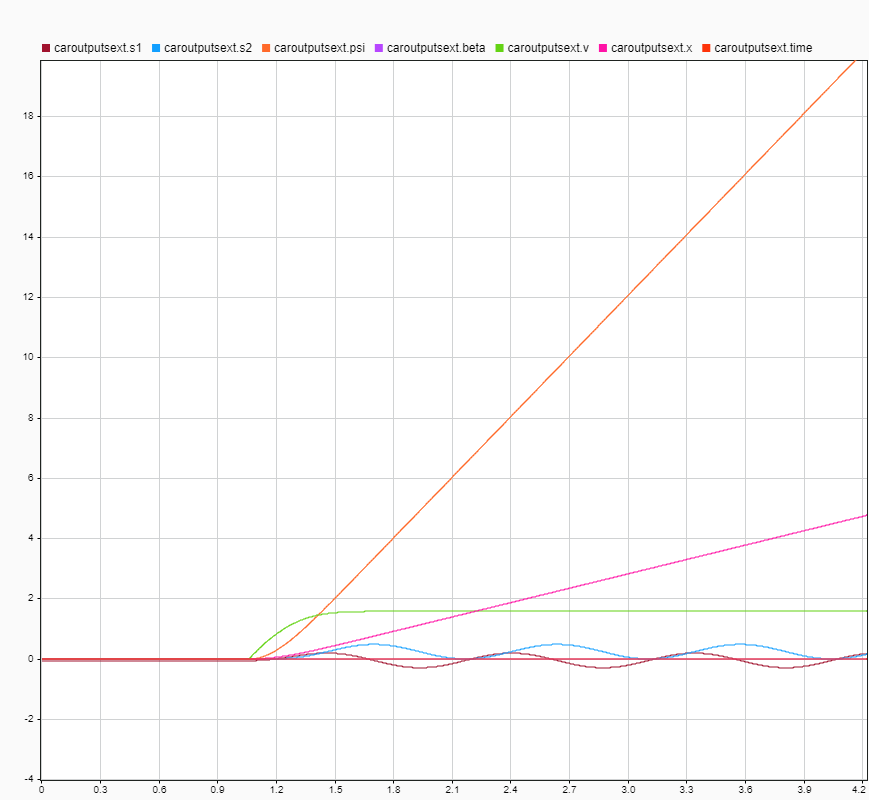


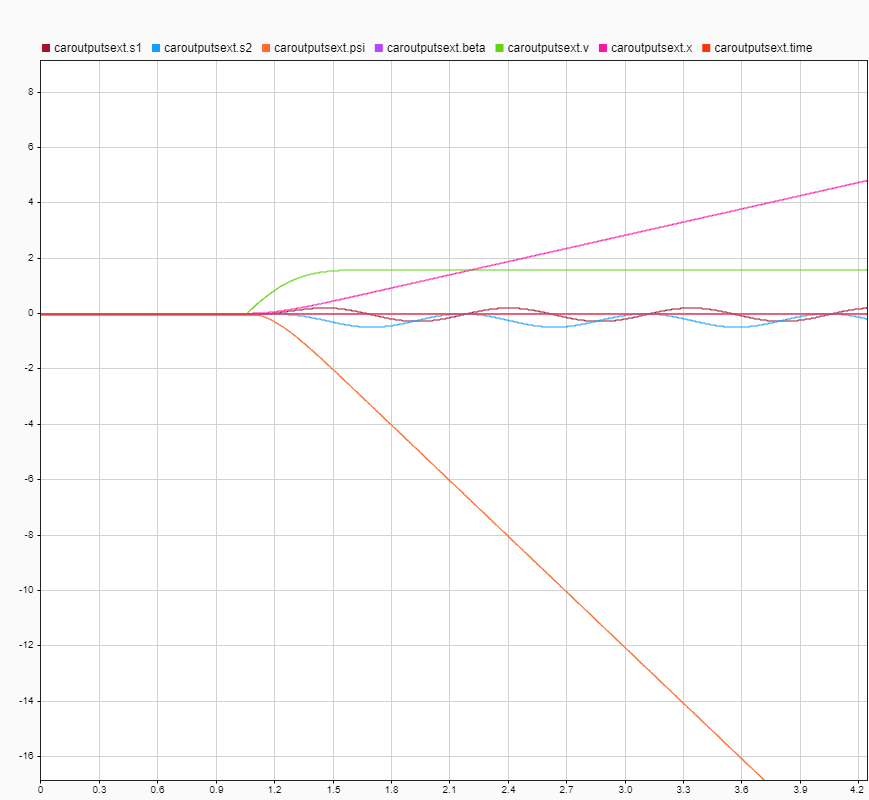
t [s]

speed [m/s]

yaw angle [rad]

1. CarInputsCommandForward, pedals = 1, δ = -0.5



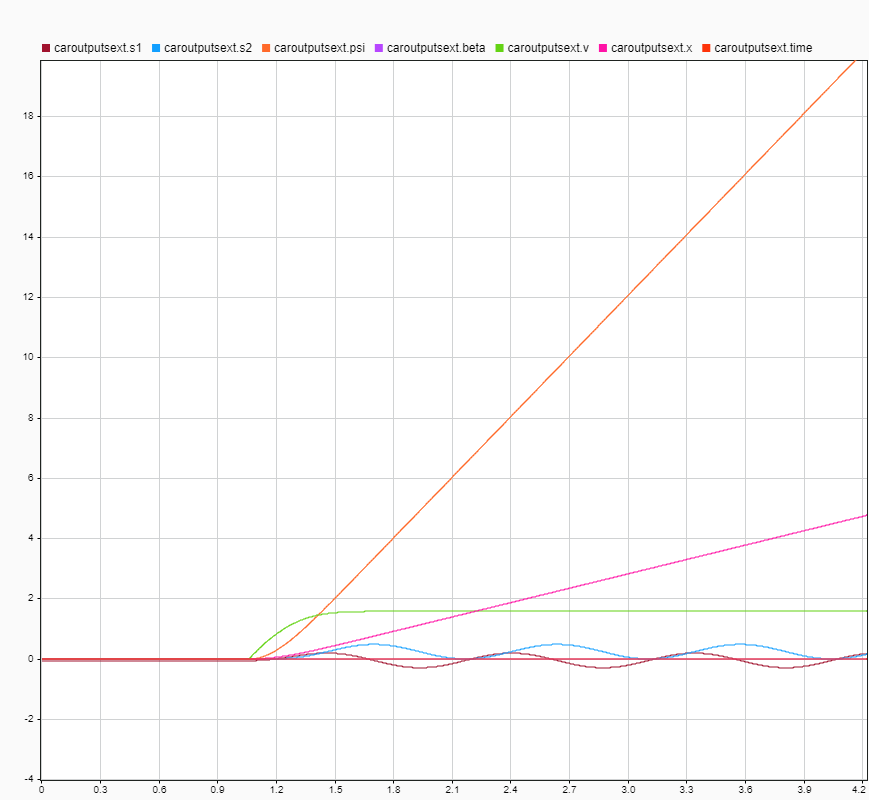


t [s]

speed [m/s]

yaw angle [rad]

1. CarInputsCommandForward, pedals = 1, δ = 0.5



t [s]

speed [m/s]

yaw angle [rad]

## Exercise 6.1 vehicle simulation

### Exercise 6.1 a) Parameter calculation

plant transfer function:

Controller transfer function:

Open-loop transfer function:

Phase of plant:

Phase of controller:

Open-loop phase:

Phase margin:

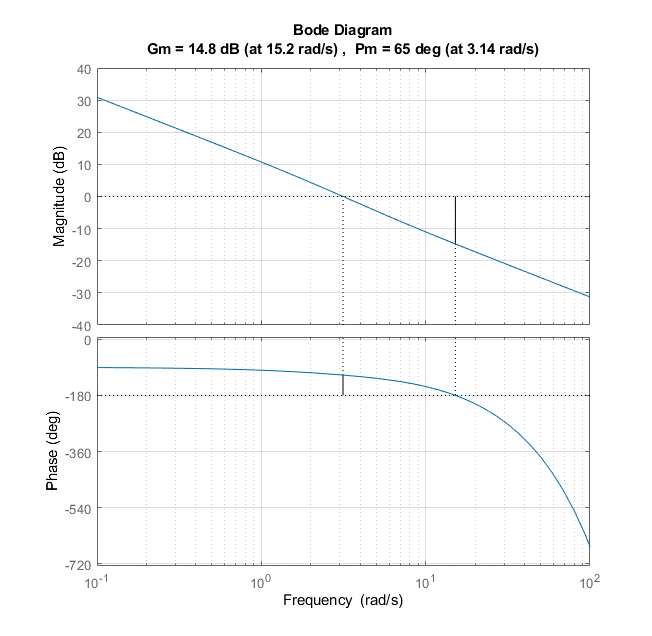
Open-loop frequency response:

Open-loop magnitude response:

### Exercise 6.1 b) Bode plot of G0(s)

See the following files:

* ex6\_1.m



### Exercise 6.1 c) Step Response of Gw(s)

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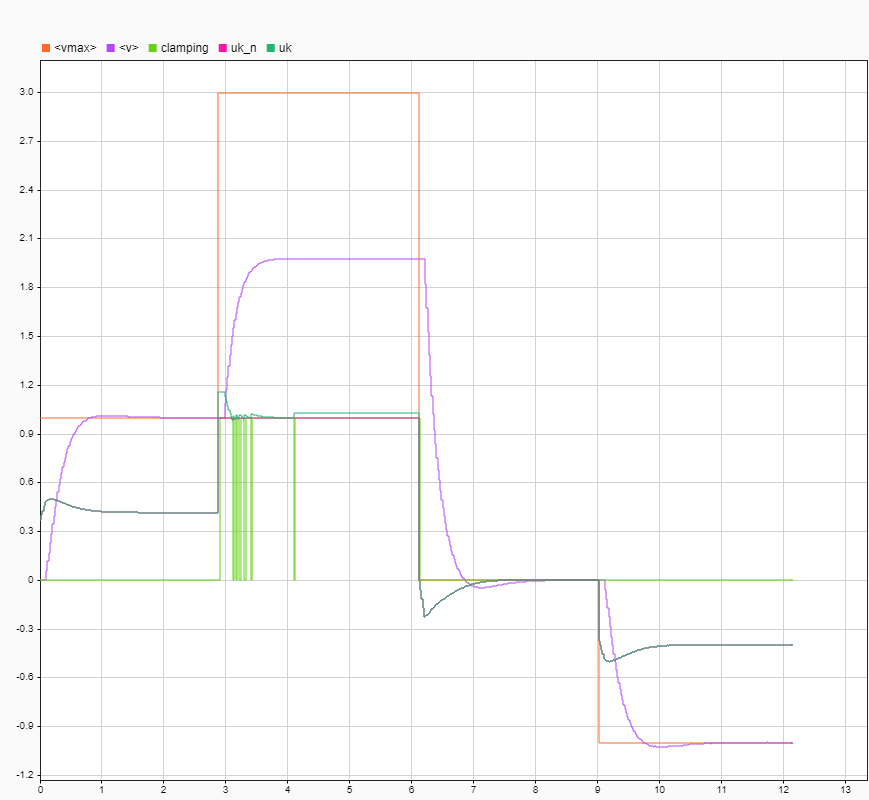
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### Exercise 6.1 d) discretization

, with

## Exercise 6.2 Speed Control simulation

Step responses of different vehicle speeds



speed [m/s]

t [s]

See also the following files:

* s6\_data.m
* s7\_template.slx (created with version R2020b)
* s7\_template.slx (converted to version R2019a)

## Exercise 8.1 Path definition of straight lines

### Exercise 8.1 a) Derivation of parameterized curve definition

### Exercise 8.1 b) Calculation of curvature, tangent vector and normal vector

Tangent vector:

Normal vector:

Curvature:

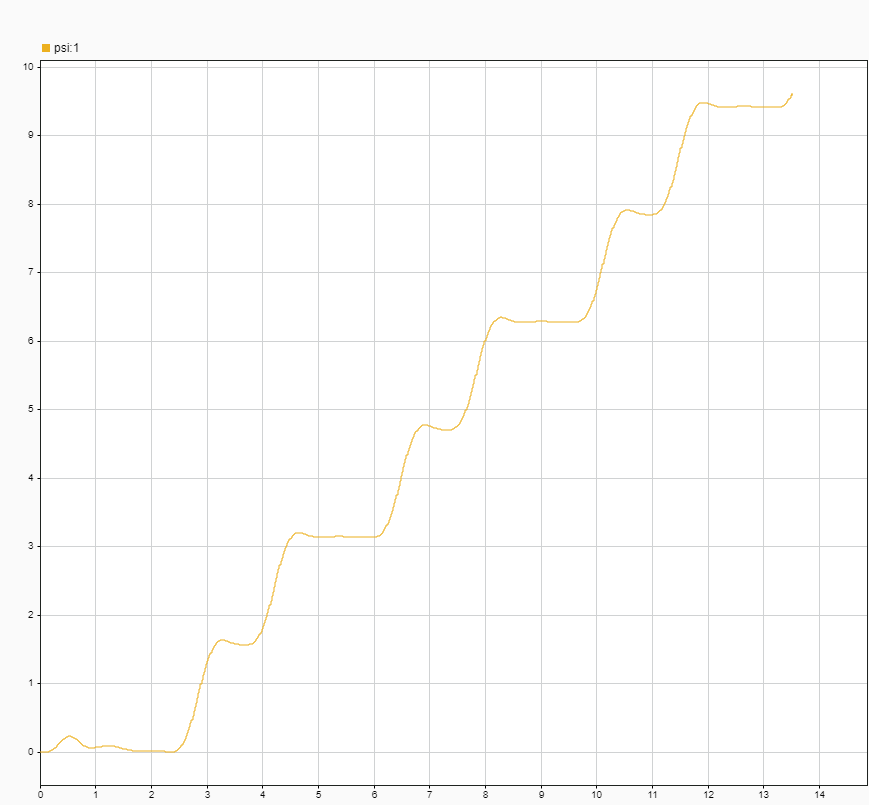
## Exercise 8.2 MODBAS CAR Function for Clothoids (not required for 2.5 ECTS)

### See the following matlab-files:

* mbc\_clothoid\_create.m
* mbc\_clothoid\_get\_points.m
* s6\_data.m

## Exercise 9.1 Path Following Controller

### Yaw-angle diagram



yaw angle [rad]

t [s]

See the following files:

* s9\_template.slx (created with version R2020b)
* s9\_template.slx (converted to version R2019a)
* s6\_data.m