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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 |

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# 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):

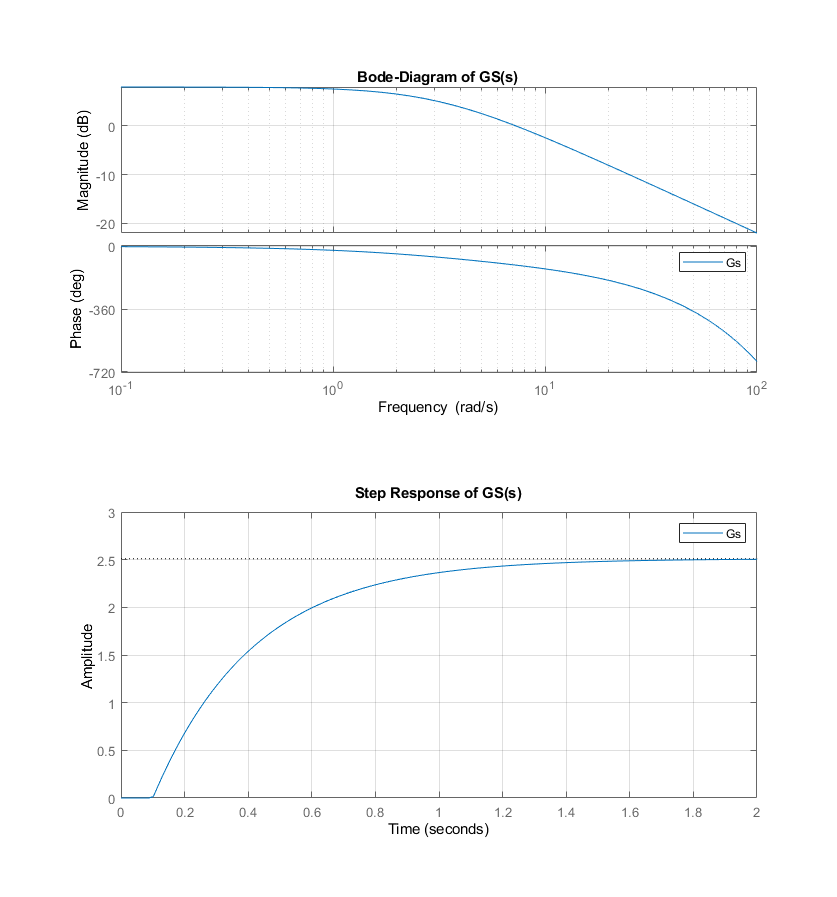
with the starting condition:

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



## Exercise 5.2 vehicle simulation

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

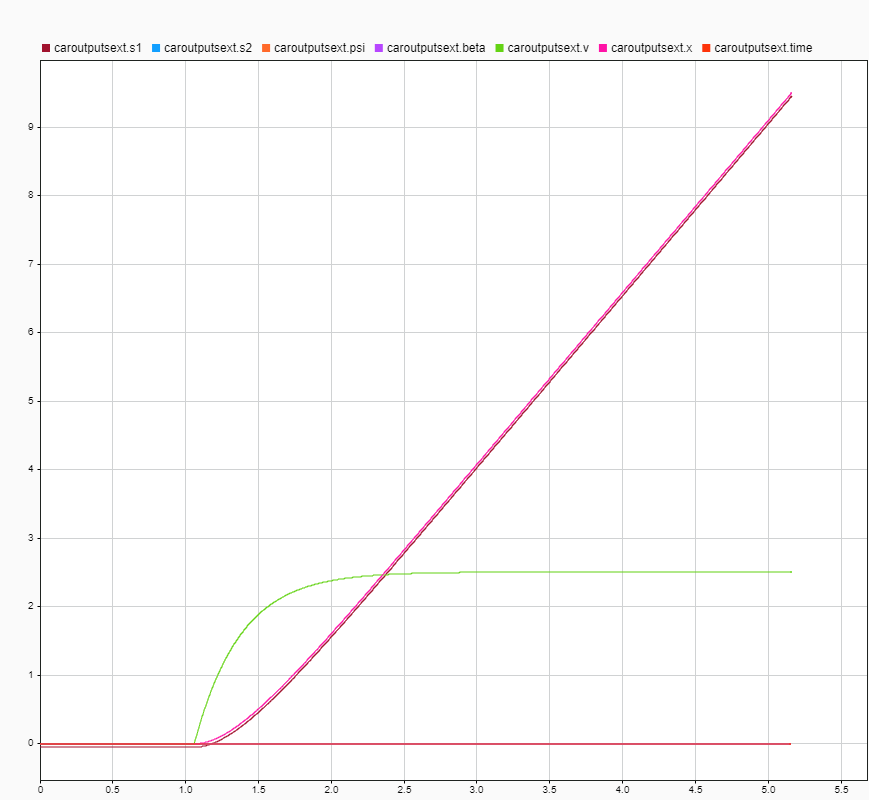
See the following file:

* s6\_template.slx

### 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

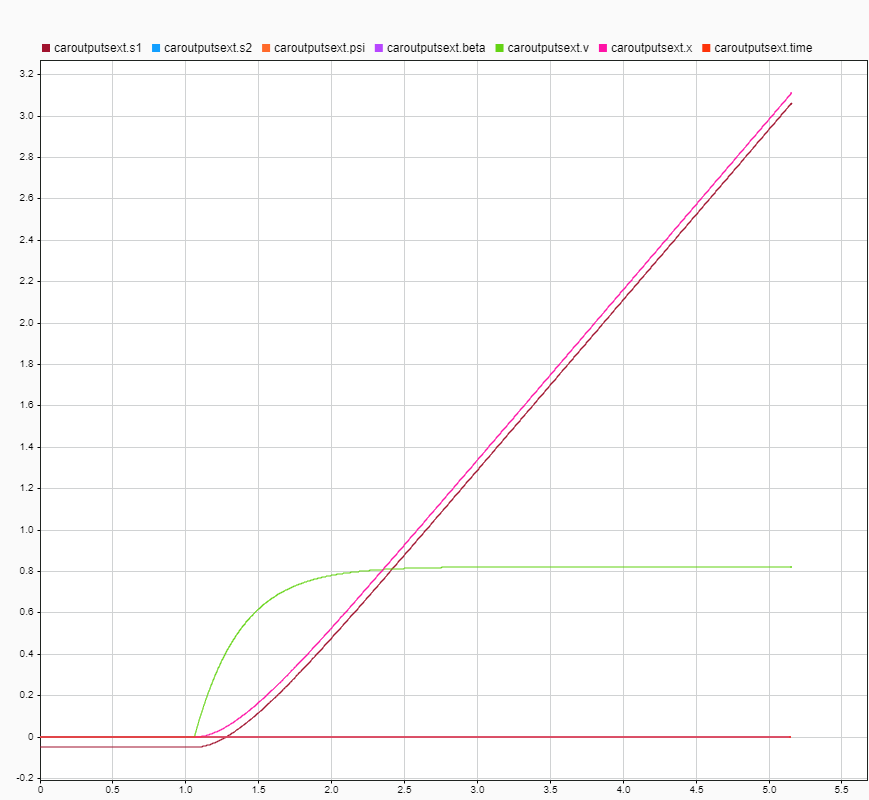


t [s]

speed [m/s]

yaw angle [rad]

1. CarInputsCommandSlow, pedals = 1, δ = 0

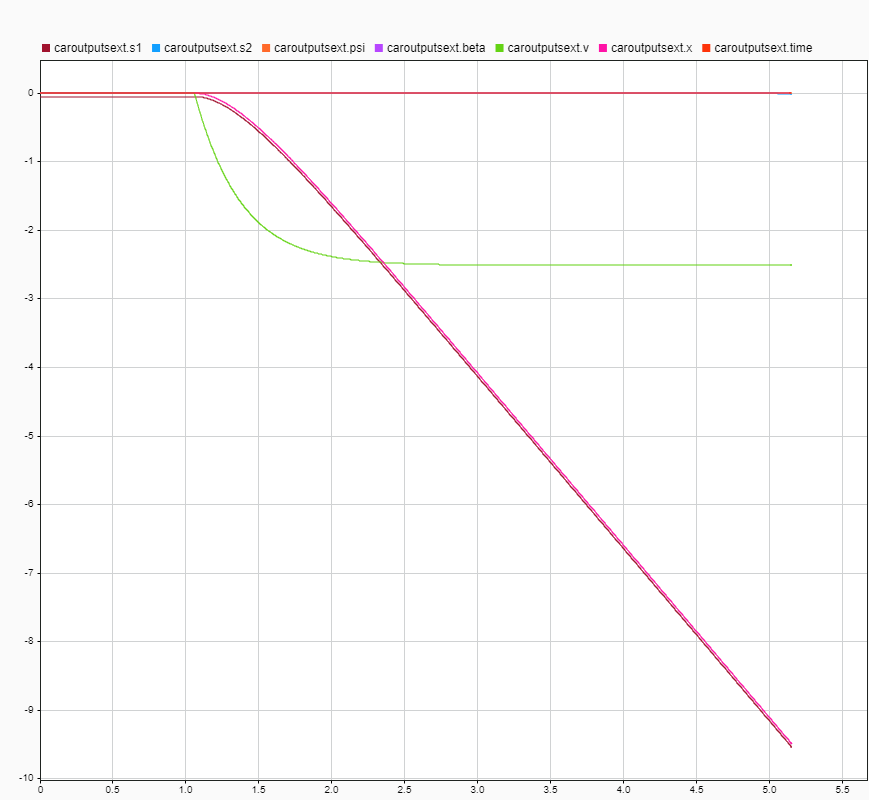


t [s]

speed [m/s]

yaw angle [rad]

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

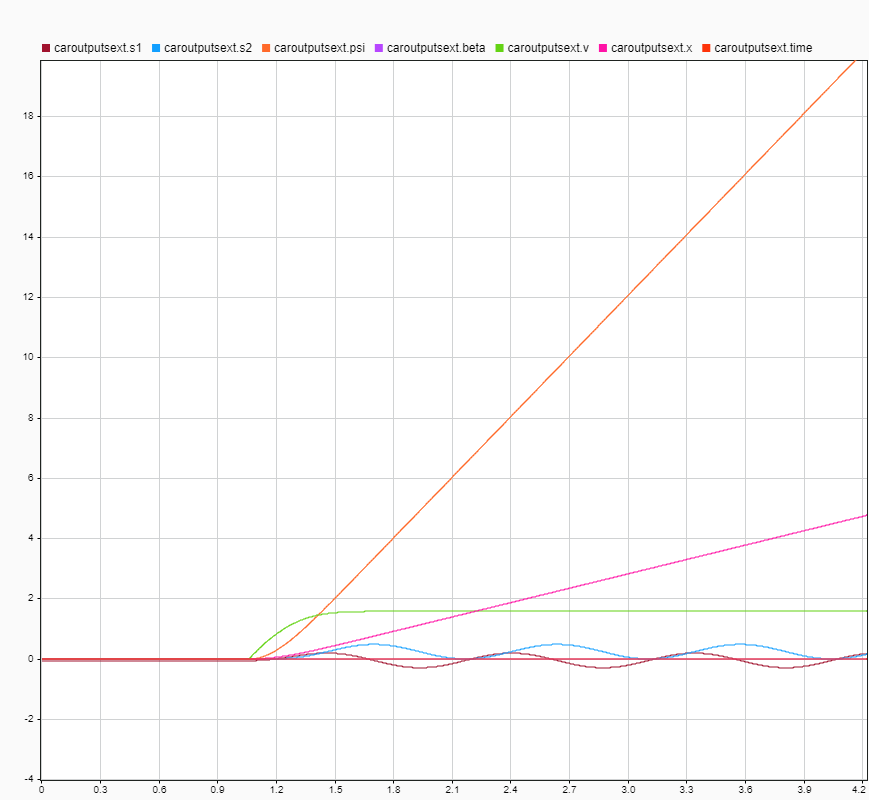


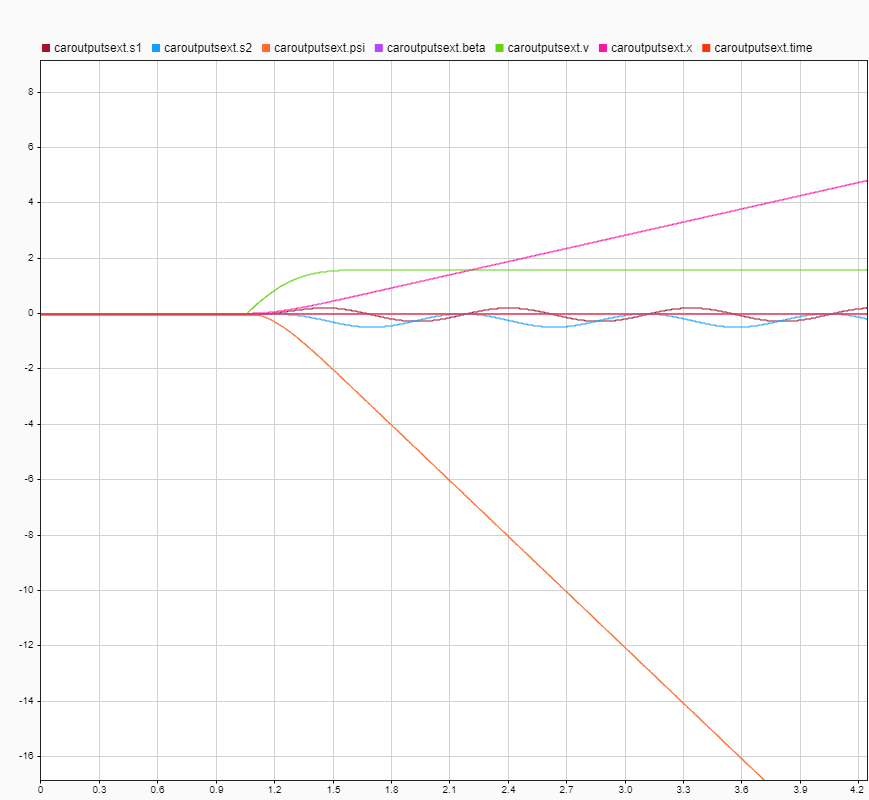
t [s]

speed [m/s]

yaw angle [rad]

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



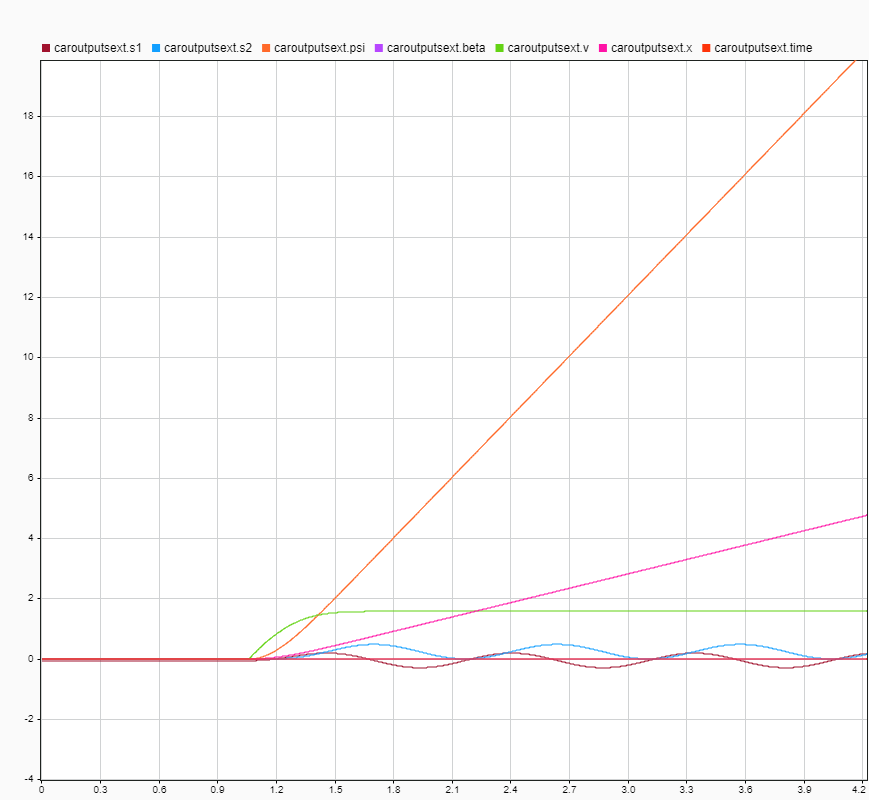


t [s]

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)

plant transfer function:

Controller transfer function:

Open-loop transfer function:

Phase of plant:

Phase of controller:

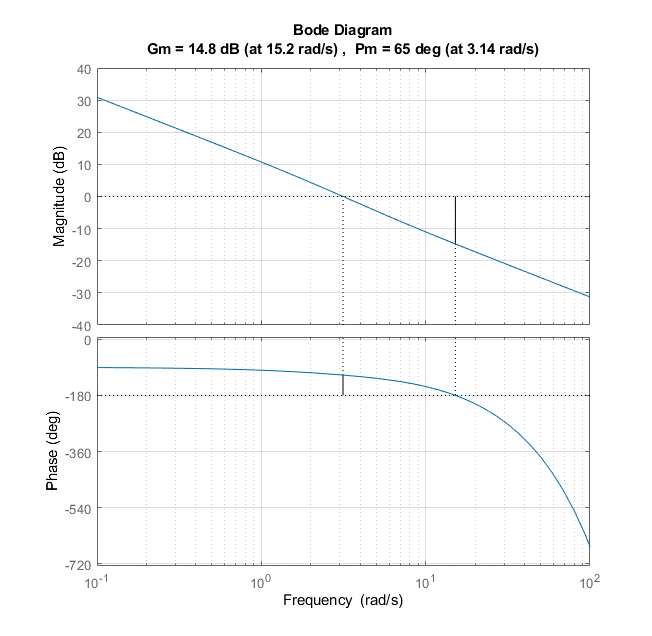
Open-loop phase:

Phase margin:

Open-loop frequency response:

Open-loop magnitude response:

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



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

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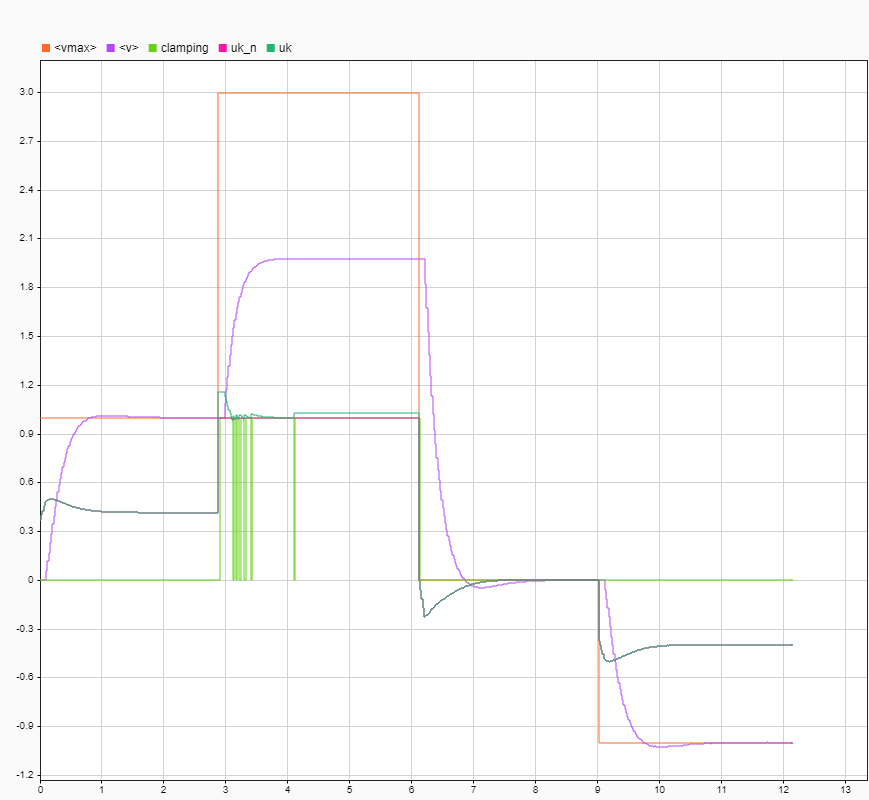
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### Exercise 6.1 d)

, with

## Exercise 6.2

Step responses of different vehicle speeds



speed [m/s]

t [s]

See also the following files:

* s6\_data.m
* s7\_template.slx

## 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:

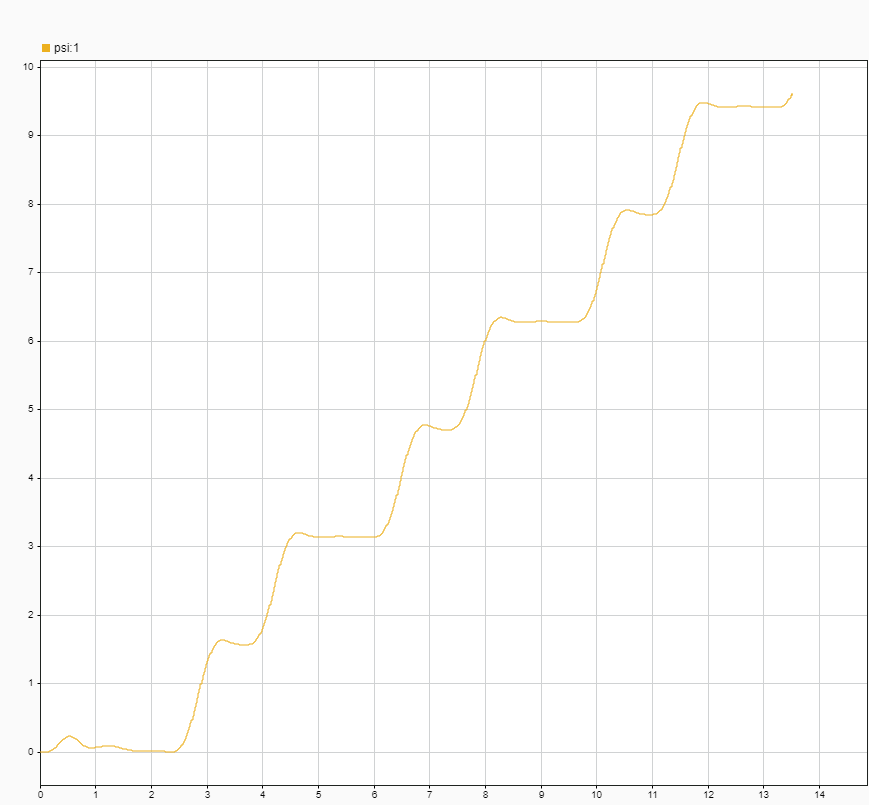
## Exercise 8.2 MODBAS CAR Function for Clothoids (not required for 2.5 ECTS)

### 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:

* s7\_template.slx
* s6\_data.m