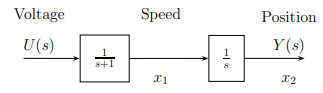
# Homework 4

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## Problem 1)

### a)



transfer function:

we get:

as and we get:

which equals:

Therefore:

### b)

### c)

The system is reachable if the controllability matrix is full rank

If the determinant of the controllability matrix is non-zero, it is full rank

The rank is full; therefore, the system is reachable.

Thus, we can choose the feedback gain such that the poles are placed as desired with Ackermann

we find and :

The gain m needs to be chosen such that the output follows the reference input

We can take use of the final value theorem to obtain the gain m:

We find :

z-transform:

z-transform:

insert X(z):

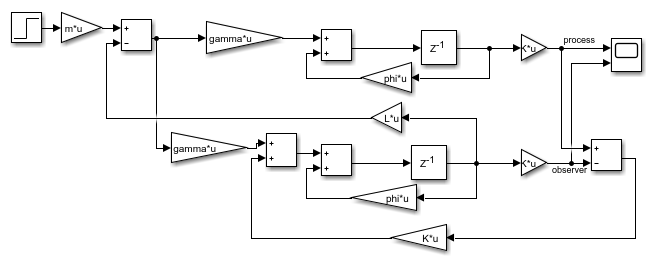
We get:

Therefore:

### d)

Only u and y are measured. State observer can be designed separately.

For the observer, we need the gain K:



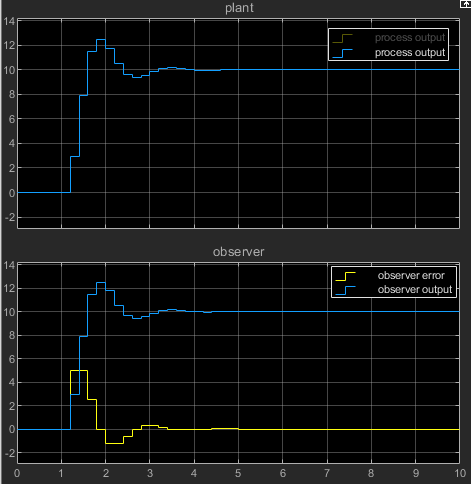


Figure 1. The final value is set to 10.

The process converges and the error goes to 0. Everything seems to work as intended.

### e)

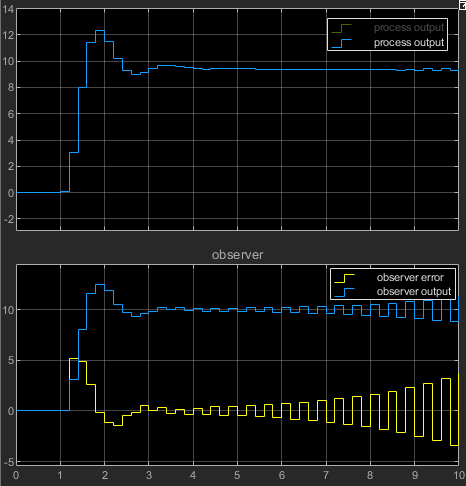
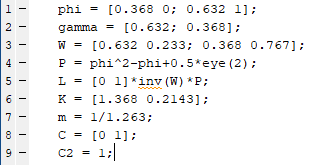


Figure 2.

My hypothesis was that the observation error would go higher and converge to 0 later. The system would remain stable.

However, it seems like the system can’t handle the disturbance. After double checking the math and going through the lecture slides, I couldn’t come up with any logical explanation why this happens….



m-code used. Math was done by hand/calculator. Included in the document.