Assignment 1

**Q1**. Performed in astrobee\_1d one\_axis\_ground\_dynamics().

**Q2.** The numerical values returned from casadi\_c2d correspond to the matrices:

and

The numerical values from analytically derived model in exercise 13 c gives the following matrices:

and

The discrete A-matrices is the same for both cases because the B matrix in general doesn’t affect the A matrix during the transition. Since the continuous B-matrices differ they are also not the same in the discrete time domain. See the equations below:

and

**Q3.** The continuous system has the following transfer function:

There are two poles at origin, i.e. 0 and no zeros in the nominator of the transferfuntion. Our intuition was that there are two poles at 0 since matrix A’s characteristic polynomial will be . For verification, see figure 1 below.

En bild som visar text, diagram, linje, Parallell

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Figure 1 - Poles for continuous system

Regarding the discrete system we expected 2 poles at 1 since the following expression:

Since this assumption holds. See the figure 2 below for verification.

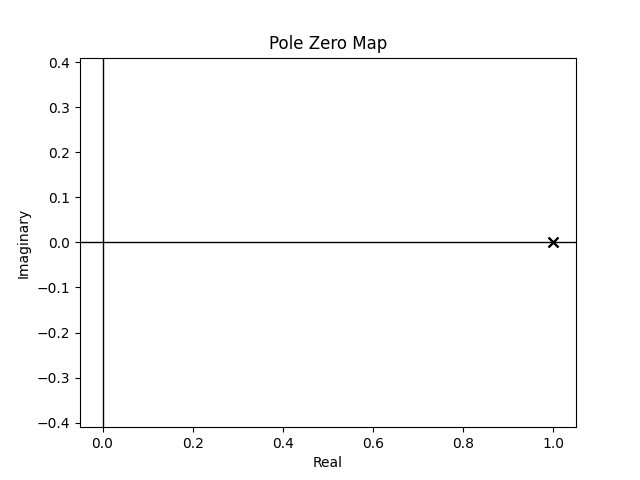


Figure 2 - poles for discrete system

**Q4.** If the control gain for the state feedback controller is designed with the two desired poles at and the requirements , and , see figure 3.

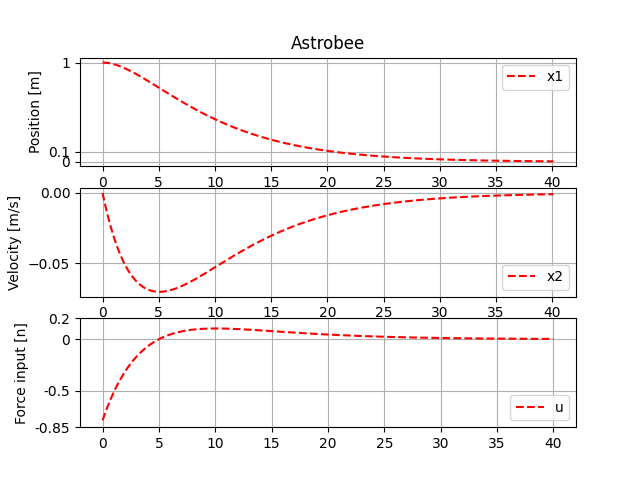


Figure 3: Control of the astrobee - Linear control without disturbance and without feedback

Including disturbances, the terminal condition couldn’t be reached, see picture 4.

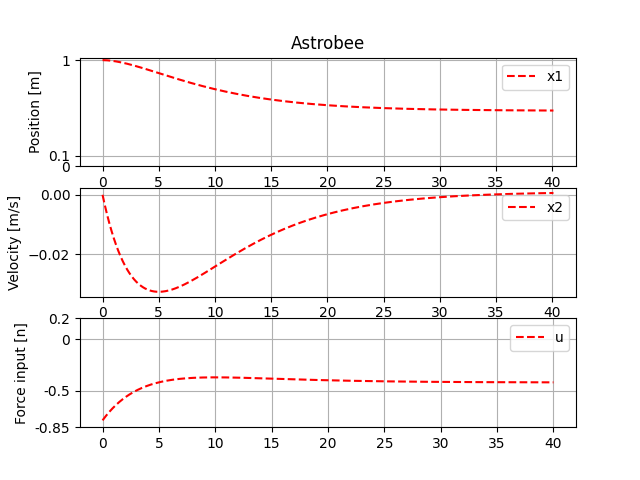


Figure 4: Control of the astrobee - Linear control with disturbance and without feedback

**Q5.** Design of Feedback loop with integral part needed to deal with disturbances. For reaching the requirement 90 % within 30 seconds, the Linear feedback gain is to be manipulated to accelerate the control with desired poles and for calculation. By implementing the integral state feedback with an integral gain the disturbance is controlled without overshooting, see figure 5.

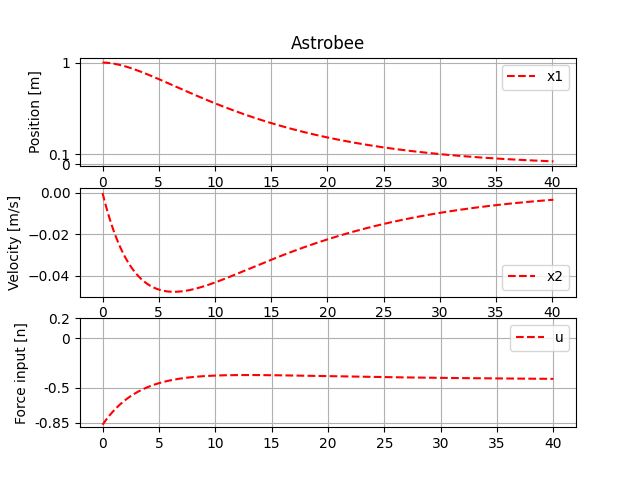


Figure 5: Control of Astrobee – Linear control, with disturbance and integral feedback control