Computerized control partial exam 2 – Dummy

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Time Whenever suits you best. Each problem should not take more than 45 min to solve. **The actual exam will only have two problems of similar workload.**

Place Somewhere quiet

Permitted aids For the exam: The single colored page with your own notes, table of Laplace transforms, calculator

All answers should be readable and well motivated (if nothing else is written). Solutions/motivations should be written on the provided spaces in this exam. Use the last page if more space is needed.

Good luck!

Matricula and name

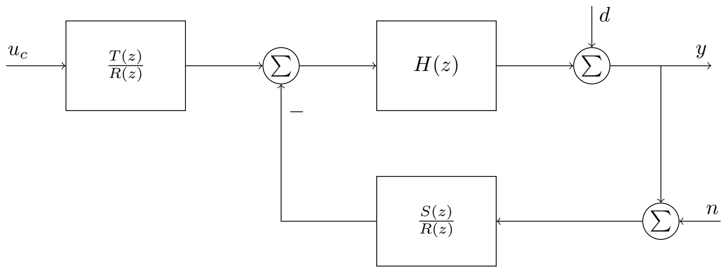


Figure 1: RST controller

Problem 1

The plant in figure 1 is described by the pulse-transfer function

$$H(z) = \frac{0.8}{z(z-0.8)}, \tag{1}$$

which is a first order system followed by a time-delay of one sampling period.

Let the desired characteristic polynomial of the closed-loop system be

$$A_{cl}(z) = \underbrace{z(z-0.7)}_{A_c(z)}\underbrace{(z-0.5)}_{A_o(z)} \tag{2}$$

and determine the polynomials $R(z)$, $S(z)$ and $T(z)$ in an RST controller of the form in figure 1. The pulse transfer function of the closed-loop system from the command signal u_c to y should be

$$H_c(z) = \frac{0.3}{z(z-0.7)}. \tag{3}$$

Derivation:

Problem 2

(Å&W problem 5.2) The plant model is described by the pulse-transfer function

$$H(z) = \frac{1}{z+a}. \tag{4}$$

Let the desired closed-loop system from the command input u_c to y be

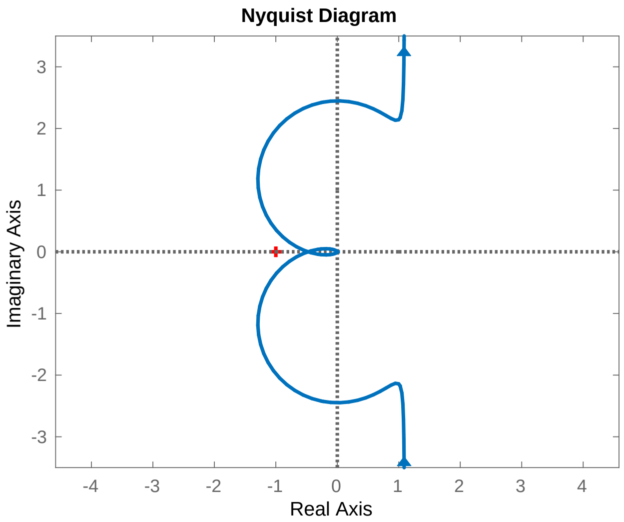
$$H_m(z) = \frac{1+\alpha}{z+\alpha} \tag{5}$$

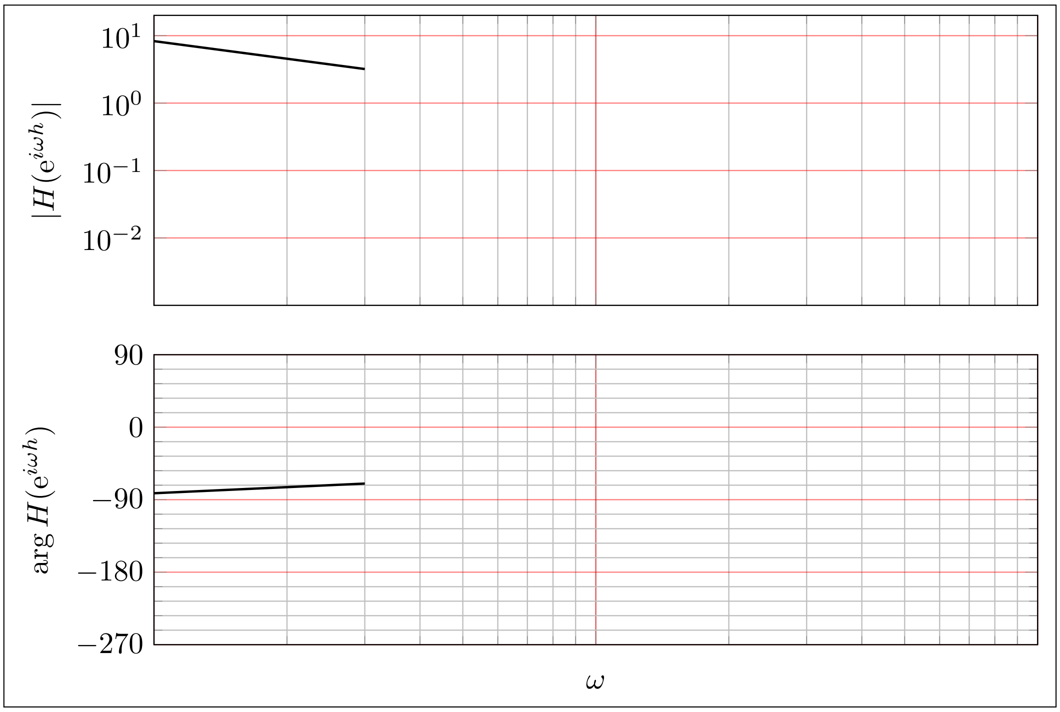
and determine an RST controller of the structure given in figure 1.

Derivation:

Problem 3

The figure below shows the Nyquist curve for the dynamics of the pitch-direction of an aircraft. **Complete the skecth of the Bode plot for the same system.** The scale on the ω-axis is not important, as long as the amplitude and phase curve are in agreement.



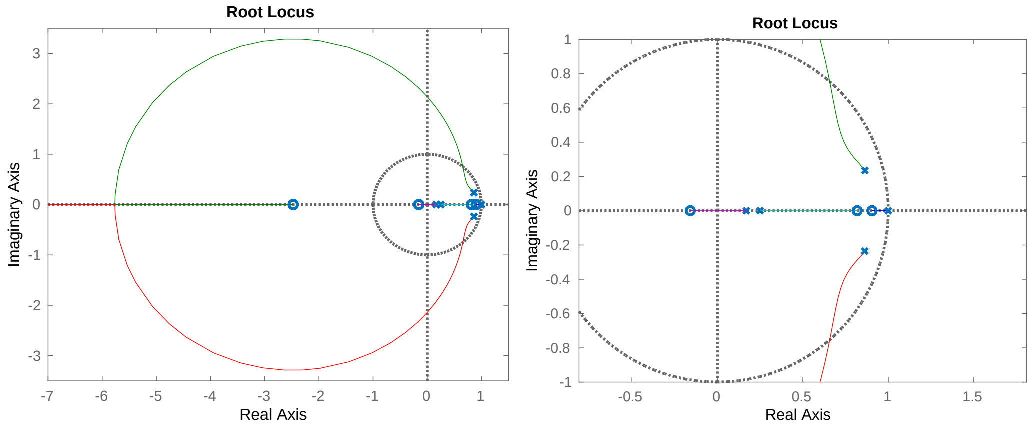


Problem 4

The aircraft model from Problem 3 is controlled with a discrete-time lead compensator $F(z) = K\frac{z-0.82}{z-0.25}$.

(a)

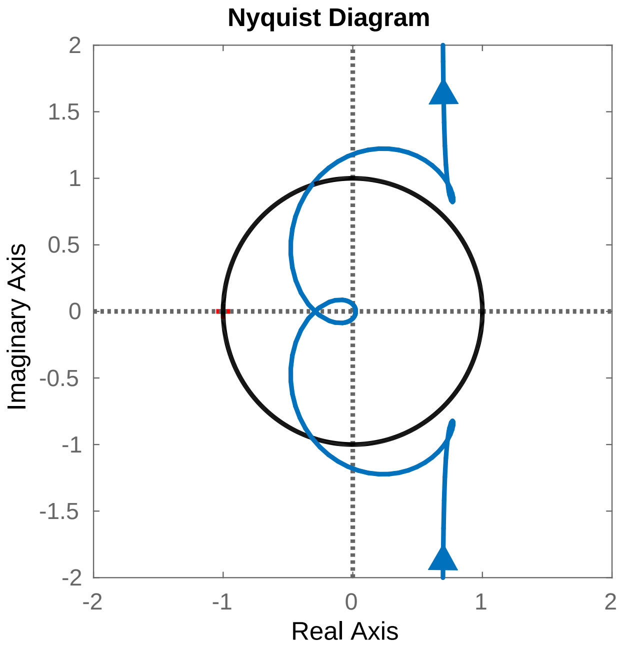
The figure below shows the root locus with respect to the gain K. **Describe briefly the properties of the closed-loop system for different values of K. Also: Mark, on the root locus in the figure, suitable closed-loop poles for the system (poles that can be obtained by some value of K).**



Description:

(b)

The figure below shows the Nyquist plot of the loop gain $H_o(z) = F(z)H(z)$. **What is the phase margin and the amplitude margin? Mark in the figure and answer below.**



A_m: φ_m:

If necessary, you can continue your solutions on this page. Mark clearly which problem the solution corresponds to.