ELEC-E8101 Digital and Optimal Control

Homework 3

Homework 3 is given on Monday 04.11.2019. To be returned electronically by Monday, 18.11.2018 at 23:55 in MyCourses portal ("Assignments").

The homeworks are not mandatory (compulsory), but they give 4 points per homework. For more information, see Course PM. It is highly recommended to do them. Solutions must be delivered in pdf-form (not Word, no Latex files, etc.). The whole solution must be written in one document and set in one file, including calculations, program codes, figures, etc. The solution file must have enough information, so that it becomes clear, how you have solved the problem. For example, the Matlab program codes and Simulink diagrams must be included in the solution document. If you want to use handwriting (and then change the document to pdf) you can do it, provided that the document can be read without difficulty. It is allowed to discuss and do the problems in groups. However, everybody must prepare and deliver his/her solutions individually. Copying directly somebody else's solution is not considered group work and is prohibited.

The above information concerns all 4 homework assignments to be given during the course.

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1. The characteristic equation of a system is given by

$$1 + G(z) = 1 + \frac{K(0.2z + 0.5)}{z^2 - 1.2z + 0.2} = 0$$

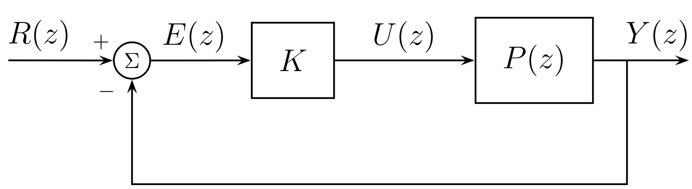
Determine the value of K, $K > 0$, for which the system is stable. [0.5p]

2. The characteristic equation of a system is given by

$$\chi(z) = z^3 - 2z^2 + 1.4z - 0.1 = 0$$

Determine whether the system is stable or not. [1p]

3. Consider the feedback system



where

$$P(z) = \frac{-1}{z^2 + z + 2}$$

and K is a constant.

a) Draw the pole/zero diagram (z-plane) for the *open-loop* system $P(z)$. Is the system stable? [0.5p]

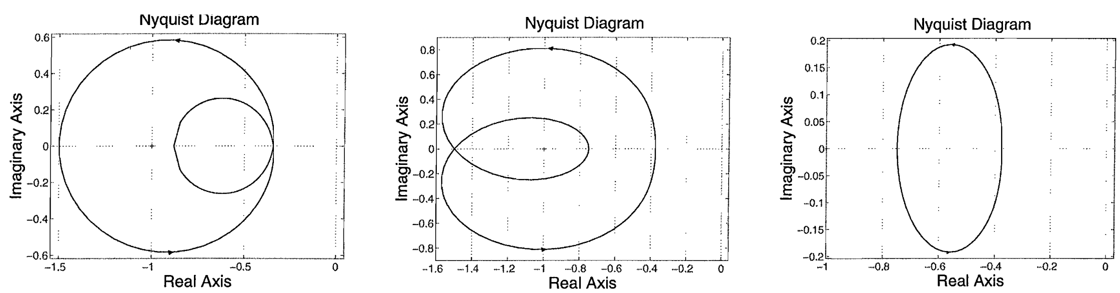
b) Show that the closed-loop transfer function from $R(z)$ to $Y(z)$ is given by [0.5p]

$$G(z) = \frac{-K}{z^2 + z + 2 - K}$$

c) For which values of K is the closed-loop stable? [0.5p]

d) Consider the closed-loop system and let the input $r[k]$ be a unit step. Find, as a function of gain K, the steady-state value of $y[k]$ (i.e., the $\lim_{k\to\infty} y[k]$) when this is finite, stating for which values of K the answer is valid. [0.5p]

e) Let $K = 1.5$. The figure below shows three Nyquist plots (A, B and C), but only one corresponds to $KP(z)$. Choose the correct one, justifying your answer with respect to



A **B** **C**

the Nyquist stability criterion. [0.5p]