Last name **Name** **student ID No.:**

PC No. _____

Section 4: STABILITY OF LINEAR DYNAMIC SYSTEMS

A linear dynamic process has the following transfer functions:

$$G_p(s)=\frac{\sqrt{\frac{n-0.05}{n+0.05}}}{(2s^2+128)^2}$$

where:

n = N. matricola (student ID No.)

I. How many and how much are the **time constants** in $G_p(s)$?

II. Is $G_p(s)$ an **open-loop** BIBO stable system?

III. Plot the **extended Nyquist diagram** *together with the unit circle and the Peak Response*, and attach it here

IV. Is the **Nyquist diagram** crossing the **critical point**?

V. Check, on the base of the **Nyquist stability criterion**, if the above system is closed-loop stable

VI. Consider a ***PD controller*** with $K_c=(n-0.05)/(n+0.05)$ and $\tau_D=(n-0.05)/[10\bullet(n+0.05)]$ s, determine its TF and introduce this TF into Matlab

VII. Consider a ***sensor block*** with the following TF and introduce this TF into Matlab

$$G_m(s)=\frac{\frac{0.5s^2+32}{2}}{\frac{n-0.05}{n+0.05}s+20}$$

VIII. Determine the open loop TF $G_{OL}(s)$ and introduce it into Matlab

IX. Convert $G_{OL}(s)$ into the **canonical form**

Part A: *Root locus*

For the open loop TF $G_{OL}(s)$, use Matlab and SisoTool resources, attach here their results and answer the following questions:

A1. Plot the *root locus* by means of Matlab or SisoTool resources and attach it here

A2. Discuss existence of a **gravity center for asymptotes**, if any, and calculate its position.

A3. Calculate the limiting value/values K^*

A4. Calculate the value of **all closed loop poles** just corresponding a given gain $K_c = 1000$

Part B: Frequency response

For the open loop TF $G_{OL}(s)$ and $\mathcal{K}c=1$,
use Matlab and SisoTool resources, attach here their results and answer the following questions:

B1) Plot the **Bode Diagrams** by means of Matlab resources, with a *log scale of the magnitude (NOT in dB),* and attach them here

B2) Does a *crossover* frequency exist? How much is it?

B3) Does a *resonance* frequency exist? How much is it?

B4) Calculate the value of $G_{OL}(j\omega)$ as a **complex number a + jb** just corresponding to a given $\omega = 10$ rad/s

B5) Decide if the **Bode stability criterion** is applicable

B6) If yes, is the above system closed-loop stable?

Part C: Dynamic responses in the time domain

For the open loop TF GOL(s) and $\mathcal{K}c=1$, use Matlab and SisoTool resources, attach here their results and answer the following questions:

C1) Plot the **open loop response** to a **impulse** input change**,** attach it here and give your comments

C2) Plot the **closed loop response** to a **impulse** input change in **disturbance,** attach it here and give your comments

Part D:

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