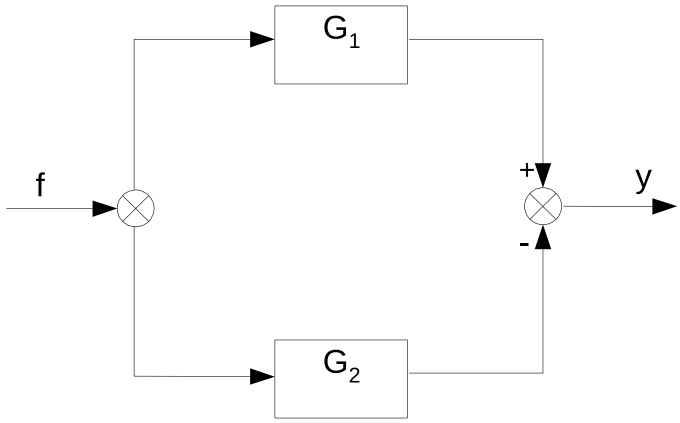
Last name **Name** **student ID No.:**

PC No. ___________

Section 4: STABILITY OF LINEAR DYNAMIC SYSTEMS

A linear dynamic system is made of two processes in this way



with transfer functions:

$$G_1(s)=\frac{\frac{n-0.05}{n+0.05}}{p\frac{n-0.05}{n+0.05}s^2+s+\frac{n-0.05}{n+0.05}} \qquad G_2(s)=\frac{\frac{1}{\sqrt{2}}\frac{n-0.05}{n+0.05}}{\frac{n-0.05}{n+0.05}s^2+s+\frac{n-0.05}{n+0.05}}$$

where:

p is a parameter
n = N. matricola (student ID No.)

I. Assign a value to the parameter *p* such as the system $G_p(s)$ resulting from the parallel is **2nd order**

II. Assign a new value to the parameter *p* such as the system $G_p(s)$ resulting from the parallel becomes an **inverse-response system**

III. Convert such an **inverse-response system** $G_p(s)$ into the **canonical form**

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

V. How much is the **gain** for such as a system $G_p(s)$ resulting from the parallel?

Part A: *Root locus*

For the **system** $G_p(s)$, 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 breakaway point, if any, and calculate its position.

A3. Calculate the limiting value/values K_*

A4. Calculate the value of **closed loop poles** just corresponding to K_*

A5. Calculate the value of **closed loop poles** just corresponding a given gain $K_c = 10$

Part B: Frequency response

For the open loop TF $G_{OL}(s)$ given by **dynamic system** $G_p(s)$ and an added ***PI controller*** with K_c=1 and $\tau_I = \sqrt{\frac{n-0.05}{n+0.05}}$ *sec*:

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 *gain crossover* frequency exist? How much is it?

B4) Calculate the value of **AR** and **ϕ** just corresponding to a given $\omega = 0.5$ rad/s

B5) Plot the **extended Nyquist diagram** *together with the unit circle and the Peak Response*, and attach it here

B6) Is the **Nyquist diagram** crossing the **critical point**?

B7) Check, on the base of the **Nyquist stability criterion**, if the above system is closed-loop stable

B8) Propose a change in $G_{OL}(s)$ such as the **Nyquist diagram** is passing exactly through the **critical point**

Part C: Dynamic responses in the time domain

Come back to the original open loop TF $G_{OL}(s)$:

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

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

Part D: Inverse Response Compensator

= = =