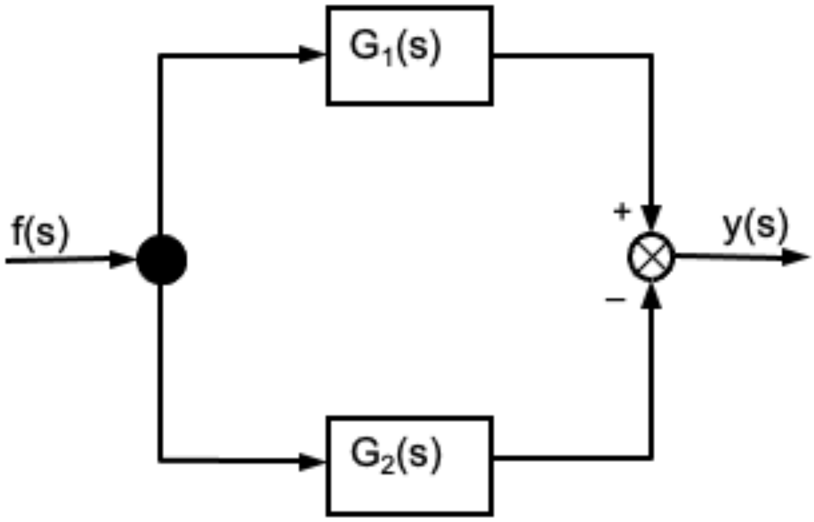
Last name **Name** **student ID No.:**

Section 4: STABILITY OF LINEAR DYNAMIC SYSTEMS

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



with transfer functions:

$$G_1(s) = \frac{a\left(\frac{n-0.05}{n+0.05}\right)}{\left[a\left(\frac{n+0.05}{n-0.05}\right)s\right]^2 + \left[a\left(\frac{n+0.05}{n-0.05}\right)\right]s + 1} \qquad G_2(s) = \frac{\frac{n-0.05}{n+0.05}}{\left(\frac{n+0.05}{n-0.05}\right)s + 1}$$

where:

n = N. matricola (student ID No.)

a is a parameter

I. Which **order** is the system $G_p(s)$ resulting from the parallel?

II. How much is the **type "g"** for such as a system $G_p(s)$ resulting from the parallel?

III. Is $G_p(s)$ a BIBO stable system at **open-loop**?

IV. Is $G_p(s)$ a **minimum phase system**?

V. Is there any damping factor? If there is, how much is ζ ?

Choose a value for "a" such as the system $G_p(s)$ resulting from the parallel is an inverse-response system

Part A: *Root locus*

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

A2. Calculate, if any, the **breakaway points** and discuss them

A3. Calculate, if any, the limiting value/values K^* and discuss them

Part B: Frequency response

For the same **dynamic system** $G_p(s)$
and ***Kc=1***, answer the following questions:

B1) Plot the **Asymptotic Bode Diagrams** by means of Matlab/SisoTool resources and attach them here

B2) Discuss the low frequency and high frequency behaviors

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

B4) Determine from the **Bode Diagrams** the limiting value K^* and compare it with the previous value found from the **root locus**

B5) Calculate the value of TF $G_p(s)$ in **polar coordinates** (AR, ϕ) at a given $\omega = 5$ rad/s

B6) Calculate the value of TF $G_p(s)$ in **cartesian coordinates** as a **complex number** $(a + jb)$ at a given $\omega = 2$ rad/s

Part C: Dynamic responses in the time domain

For the same **dynamic system** $G_p(s)$, answer the following questions:

C1. Plot the **open-loop** dynamic response to **unit step** by means of Matlab/SisoTool resources, attach it here and give your comments

Choose a new value for "a" such as the new system $G_{new}(s)$ resulting from the parallel has a zero at origin

Part A bis: *Root locus*

A4. Plot the root locus by means of Matlab and SisoTool resources and attach it here

A5. Calculate, if any, the limiting value/values K^* and discuss them

Part B bis: Frequency response

For the new **dynamic system** $G_{new}(s)$
and ***Kc=1***, answer the following questions:

B7) Plot the **extended Nyquist diagram** together with the unit circle and the Peak Response, by means of Matlab and SisoTool resources, and attach it here

B8) Check if the the **extended Nyquist diagram** is passing through the **critical point**

B9) Check if the **Nyquist** stability criterion is applicable and, possibly, if the above system is closed-loop stable

Part C bis: Dynamic responses in the time domain

For the same **dynamic system** $G_{new}(s)$, answer the following questions:

C2. Plot the **open-loop** dynamic response to **unit step** by means of Matlab/SisoTool resources, attach it here and give your comments

Finally

C3. Compare and comment the two **open-loop** dynamic responses to **unit step** in plots obtained under C1) and C2) above

Part D: = = =