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

PC No. ___________

Section 4: STABILITY OF LINEAR DYNAMIC SYSTEMS

A dynamic process has the following linear system transfer function (TF):

$$G_p(s) = \frac{\dfrac{n-0.05}{n+0.05}}{\left(s+1.25\dfrac{n-0.05}{n+0.05}\right)\left(s+12.5\dfrac{n-0.05}{n+0.05}\right)(s+p)^2}$$

where:

n = PC No.

p is a parametric **pole**

I. What is the **classification** you give to this type of TF?

II. Is this an **inverse response** system?

Part A: *Root locus*

For the **dynamic system** $G_p(s)$, by using as much as possible the Matlab or SisoTool resources, answer here the following questions.

Choose a real negative value for p

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

Choose a null value for p

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

Choose a real positive value for p

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

Part B: Frequency response

For the **dynamic system** $G_p(s)$, by using as much as possible the Matlab or SisoTool resources, answer here the following questions:

Choose a real negative value for p

1) Plot the **extended Nyquist Diagram** *together with the unit circle and the Peak Response*, attach it here and comment it

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

Choose a null value for p

3) Plot the **extended Nyquist Diagram** *together with the unit circle and the Peak Response*, attach it here and comment it

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

Choose a real positive value for p

5) Plot the **extended Nyquist Diagram** *together with the unit circle and the Peak Response*, attach it here and comment it

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

Consider the 3 different choices made for the parametric **pole** and discuss:

7) which is the resulting $G_p(s)$ that is more prone to closed loop instability

8) Explain why

Part C: Dynamic responses in the time domain

For the **dynamic system** $G_p(s)$ that allows for closed loop stability as much as possible:

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

b) Plot the **closed loop response** $y_d(t)$ to a unit step **input** change in **disturbance,** attach it here and give your comments

c) Calculate the value of the **closed loop response** $y_d(t)$ at a time just equal to twice the smallest time constant in $G_p(s)$

Part D:

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