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

PC No. ___________

Section 4: STABILITY OF LINEAR DYNAMIC SYSTEMS

A dynamic process $G_p(s)$ has the following transfer function

$$G_p = \frac{1}{n}\frac{\left(\frac{-n-0.25}{n+0.25}\right)^n}{\left(ns^2+\frac{1}{n}\right)}$$

where n = PC No.

I. Is this a rational **transfer function**?
II. How much is type “g”?
III. How much is the **gain**?
IV. How many and how much are the **time constants**?

Part A: *Root locus*

For the **system** $G_p(s)$:

1. Plot the *root locus* by means of Matlab and SisoTool resources and attach it here
2. Is it a direct or inverse *root locus*?
3. Provide a *short comment* to the trajectories

Part B: Frequency response

For the **dynamic system** $G_p(s)$ and a *P controller with* K_c=1:

1) Plot the **Bode Diagrams** by means of Matlab resources, with a *log scale of the magnitude (NOT in dB)*, and attach them here
2) Does a **resonance** frequency exist? How much is it?
3) Decide if the Bode stability criterion is applicable
4) If yes, is the above system closed-loop stable?
5) Plot and attach here the **extended Nyquist diagram** *together with the unit circle* by means of Matlab resources, then discuss it in details
6) Check, on the base of the **Nyquist** stability criterion, if the above system is closed-loop stable

Part C: Dynamic responses in the time domain

Take the following three dynamic systems**,** all in series in the control loop:

a ***P controller***, with *a convenient value of* $\mathcal{K}_c$ according to your best judgement,
the above **dynamic system** $G_p(s)$,
a measuring system $G_m(s)$:

$$G_m = \frac{(-1)^{n+1}}{s + \left(\frac{n - 0.25}{n + 0.25}\right)}$$

where n = PC No.

Then, use the Matlab resources to:

a. plot the **open-loop** dynamic response to a **unit step**, attach it here
b. plot the **open-loop** dynamic response to **impulse**, attach it here and compare to **unit step**
c. plot the **closed-loop** dynamic response to a **unit step** in the **set point,** attach it here and give your comments
d. plot the **closed-loop** dynamic response to a **unit step** in the **disturbance,** attach it here and give your comments

Part D:

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