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

PC No. ___________

Section 4: STABILITY OF LINEAR DYNAMIC SYSTEMS

A dynamic process $G_p(s)$ is made of 2 sub-systems in series having the following transfer functions

$$G_{p1} = \frac{1}{n}\frac{\left(\frac{n-0.25}{n+0.25}\right)^n}{\frac{1}{n}s + \frac{1}{n^{\left(\frac{n-0.25}{n+0.25}\right)}}}$$

$$G_{p2} = \frac{\left(\frac{n-0.25}{n+0.25}\right)^n}{s^2 + \left(\frac{n-0.25}{n+0.25}\right)s + \frac{1}{\left(\frac{n-0.25}{n+0.25}\right)}}$$

where n = PC No.

I. Is $G_p(s)$ an **inverse response system**?
II. How much is **type "g"**?
III. How much is the **gain**?
IV. How many and how much are the **time constants**?
V. How many and how much are the **damping factors**?

Part A: *Root locus*

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

A.1. Plot the root locus by means of Matlab and SisoTool resources and attach it here
A.2. Calculate the value of the **critical gain** K_c*
A.3. Discuss in detail the closed loop BIBO stability of the system when K_c is increased from zero

Part B: Frequency response

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

B.1. Plot the **asymptotic Bode Diagrams** by means of the ASBODE script, and attach them here
B.2. Does one or more **resonance frequencies** exist? How much is the value?

B.3. Does a **crossover frequency** exist? How much is it?

B.4. Does a **gain crossover frequency** exist? How much is it?

B.5. Plot and attach here the **extended Nyquist diagram** *together with the unit circle and the Peak Response* by means of Matlab and SisoTool resources, then discuss it in details

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

B.7. Starting from the **transfer function** $G_p(s)$ (and a ***P controller** with* K_c=1), propose a change such as the resulting new **dynamic system** $G_{pnew}(s)$ has the **extended Nyquist diagram** passing through the **critical point at −1** exactly

B.8. Plot and attach here such a new **extended Nyquist diagram** *together with the unit circle and the Peak Response* demonstrating the crossing of the real axis at the **critical point −1** exactly

Part C: Dynamic responses in the time domain

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

C.1. plot the **open-loop** dynamic response to unit step, attach it here and give your comments

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

C.2. plot the **closed-loop** dynamic response to a unit step in **set point**, attach it here and give your comments

For the **system** $G_{pnew}(s)$ and a ***P controller** with* K_c=1:

C.3. plot the **closed-loop** dynamic response to a unit step in **set point**, attach it here and give your comments

Part D:

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