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

PC No. ___________

Section 4: STABILITY OF LINEAR DYNAMIC SYSTEMS

A linear dynamic process has the following transfer functions:

$$G_2(s) = \frac{(s+1)}{\left(s - 2 \cdot \left(\frac{n-0.05}{n+0.05}\right)\right)} e^{-4 \cdot \left(\frac{n-0.05}{n+0.05}\right)s}$$

where:

n = N. matricola (student ID No.)

I. Is $G_2(s)$ a BIBO stable system at **open-loop**?

II. How much is the **gain**?

III. Is $G_2(s)$ an **inverse-response system**?

Part A: *Root locus*

For the open loop TF $G_2(s)$, answer the following questions aimed at focusing the Padé approximation:

A1. Use a 1st order Padé approximation, plot the *root locus* by means of Matlab or SisoTool resources and attach it here

A2. Calculate the limiting value/values K_{1^*}, if any

A3. Use a 2nd order Padé approximation, plot the *root locus* by means of Matlab or SisoTool resources and attach it here

A4. Calculate the limiting value/values K_{2^*}, if any

A5. Use a 3rd order Padé approximation, plot the *root locus* by means of Matlab or SisoTool resources and attach it here

A6.Calculate the limiting value/values K_{3^*}, if any

A7.By comparing all of the above results for the *root locus*, provide a short and reasoned comment

Part B: Frequency response

For the open loop TF $G_2(s)$ and ***Kc=1***, answer the following questions:

B1)Use a 1st order Padé approximation, plot the **Bode Diagrams** by means of Matlab or SisoTool resources, with a *log scale of the magnitude (NOT in dB),* and attach them here

B2)Use a 2nd order Padé approximation, plot the **Bode Diagrams** by means of Matlab or SisoTool resources, with a *log scale of the magnitude (NOT in dB),* and attach them here

B3) Use a 3rd order Padé approximation, plot the **Bode Diagrams** by means of Matlab or SisoTool resources, with a *log scale of the magnitude (NOT in dB),* and attach them here

B4)Come back to the original TF $G_2(s)$, plot the **Bode Diagrams** by means of Matlab resources, with a *log scale of the magnitude (NOT in dB),* and attach them here

B5)Calculate the value of each TF in both **polar coordinates** (AR, ϕ) and **cartesian coordinates complex number** (a + jb) just corresponding to a given ω = 100 rad/s, for all of the above four cases above

B6)By comparing all of the above results for the **Bode Diagrams**, provide a short and reasoned comment

B7)Use a 1st order Padé approximation, plot the **extended Nyquist Diagram** by means of Matlab or SisoTool resources, *together with the unit circle and the Peak Response,* and attach it here

B8)Is the above **Nyquist diagram** crossing the **critical point**?

B9) Check, on the base of the **Nyquist stability criterion**, if the above system is closed-loop stable

B10) Come back to the original TF $G_2(s)$, plot the **extended Nyquist Diagram** by means of Matlab or SisoTool resources, *together with the unit circle and the Peak Response*, and attach it here

B11) By comparing the above two **Nyquist Diagrams**, provide a short and reasoned comment

Part C: Dynamic responses in the time domain

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Part D:

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