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

Section 4: STABILITY OF LINEAR DYNAMIC SYSTEMS

We have transfer functions for three linear dynamic sub-systems:

$$G_{p1} = \frac{1}{n} \frac{\left(\frac{n-0.05}{n+0.05}\right)^n}{\frac{s}{n}+\frac{1}{n\left(\frac{n-0.05}{n+0.05}\right)}} \quad G_{p2} = \frac{1}{n} \frac{1}{\frac{s}{n}+\frac{100}{n\left(\frac{n-0.05}{n+0.05}\right)}} \quad G_{p3} = \frac{1}{n} \frac{\left(\frac{n-0.05}{n+0.05}\right)^n}{\frac{s}{n\left(\frac{n-0.05}{n+0.05}\right)}}$$

where:

n = N. matricola (student ID No.) OR **at least** the two last digits of N. matricola

The 3 sub-systems can be connected in series:

I. What is the resulting **TF** $G_{p,series}(s)$?

II. How much is the **type g** in $G_{p,series}(s)$?

or the 3 sub-systems can be connected in parallel:

III. What is the resulting **TF** $G_{p,parallel}(s)$?

IV. Convert $G_{p,parallel}(s)$ in the **canonical form**

For the **dynamic system** $G_{p,series}(s)$:

Part A: *Root locus*

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

A.2. Determine the value, if any, of the **breakaway point**

A.3. Calculate the value, if any, of the **critical gain** K_c*

Part B: Frequency response

B.1. Plot the **asymptotic Bode Diagrams** by means of the ASBODE script, attach them here *and briefly comment them*

B.2. 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 detail

B.3. Check, on the base of the **Nyquist** stability criterion, if the above system is closed-loop stable

For the **dynamic system** $G_{p,parallel}(s)$:

Part A: *Root locus*

A.4. Plot the root locus by means of Matlab and SisoTool resources and attach it here

A.5. Calculate the value, if any, of the **critical gain** K_c^*

Part B: Frequency response

B.4. Plot the **Bode Diagrams**, attach them here *and briefly comment them*

B.5. Calculate the value, if any, of $G_{p,parallel}(j\omega)$ as a complex number a + jb in correspondence of the maximum/maxima of $\phi(\omega)$

B.6. Can the **Bode Stability criterion** be applied? Please *briefly comment on it*

B.7. 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 detail

B.8. 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

Based on the **Root locus** and **Frequency responses** obtained above, decide *in a clear way*

C.1. which open loop system, i.e., $G_{p,series}(s)$ or $G_{p,parallel}(s)$, is more prone to **closed loop instability**

Then, use it in the following:

C.2. select a type of forcing function, if any, that will determine a **self-regulating dynamic response at open-loop** and then plot it, attach it here and give your comments

C.3. with a ***P controller** with* K_c=0.1,
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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