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

$$G_p(s) = \frac{n-0.05}{n+0.05} \cdot \frac{s+2}{s\left(s+\frac{n-0.05}{n+0.05}\right)\left(s+3\frac{n-0.05}{n+0.05}\right)}$$

where n = PC No.

I. Classify $G_p(s)$ according to the given shape
II. How much is the **type**?
III. How much is the **gain**?

Part A: *Root locus*

By using as much as possible the Matlab or SisoTool resources, answer here the following questions:

1. Explain if you've to use **direct or inverse** Root Locus rules
2. Plot the *root locus* by means of Matlab or SisoTool resources and attach it here
3. Calculate, if any, and comment the value/values of the **breakaway point**
4. Calculate, if any, and comment the value/values of the **critical gain** K*

Part B: Frequency response

By using as much as possible the Matlab or SisoTool resources, answer here the following questions:

1) Plot the **Bode Diagrams** by means of Matlab resources *with AR not in dB* and attach them here
2) Does a *crossover* frequency exist? How much is it?
3) Does a *gain crossover* frequency exist? How much is it?
4) Decide if the Bode stability criterion is applicable
5) If yes, is the above system closed-loop stable?

6) Plot the **extended Nyquist diagram** *together with the unit circle and the Peak Response* by means of Matlab resources, attach it here and give your comments in details

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

8) Calculate the **delay margin**

9) Provide here the definition and the units of the **delay margin**

10) Determine the transfer function $G_{dt}(s)$ of a new subsystem consisting in a **dead time**, with the numerical value of this latter being equal to the **delay margin**

11) Determine the open loop transfer function $G_{OL}(s)$ when the new subsystem $G_{dt}(s)$ is coupled to the original dynamic process $G_p(s)$

12) Demonstrate and discuss the **closed loop stability** properties of $G_{OL}(s)$

Part C: Dynamic responses in the time domain

For the **system** $G_{OL}(s)$:

1 - Plot the **closed loop response** to a unit step change in the **set point,** attach it here and give your comments

Part D: Dead time compensation

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