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

Section 4: STABILITY OF LINEAR DYNAMIC SYSTEMS

A dynamic process $G_p(s)$ is the result of 2 linear systems in series, each having the following transfer function

$$G_1(s)=\frac{n+0.15}{n-0.15}\frac{1}{s^3}$$

$$G_2(s)=\frac{1}{10}\frac{\left(\frac{s}{0.2}+1\right)^2}{\left(\frac{s}{4.5}\cdot\frac{n+0.15}{n-0.15}+1\right)^2}$$

where n = PC No.

I. Determine all open loop **poles** and **zeroes**

II. Determine all **time constants** in the polynomials at numerator and denominator

III. How much is the **type g**?

IV. Is there any **damping factor**? If there is, how much is ζ ?

Part A: *Root locus*

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

A1. Explain if you've to use **direct or inverse** Root Locus rules

A2. Plot the *root locus* by means of Matlab and SisoTool resources and attach it here

A3. Calculate, if possible, the value/values of the critical gain K*

Part B: Frequency response

For the **original dynamic system** $G_p(s)$ reported on top, with $K_c = 1$:

B1. Plot the **Bode Diagrams** by means of Matlab resources and attach them here

B2. Does a *crossover* frequency exist? How much is it?

B3. Does a *gain crossover* frequency exist? How much is it?

B4. Decide if the Bode stability criterion is applicable

B5. If yes, is the above system closed-loop stable?

B6. 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

B7. Check, on the base of the **Nyquist** stability criterion, if the above system is closed-loop stable

B8. By means of the **gain margin**, calculate the limiting value $K_{c,lim}$ and compare it with the previously found value K*

Part C: Dynamic responses in the time domain

For the **dynamic system** $G_{p.}(s)$ with $K_c=5$:

C1. Plot the **closed loop response** to a unit step change in the **set point,** attach it here and give your comments

For the **dynamic system** $G_{p.}(s)$ with $K_c=0.05$:

C2. Plot the **closed loop** time profile of the **manipulated variable** to a unit step change in the **set point,** attach it here and give your comments

Part D: = = =

D1. : = = =