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

PC No. ___________

Section 4: STABILITY OF LINEAR DYNAMIC SYSTEMS

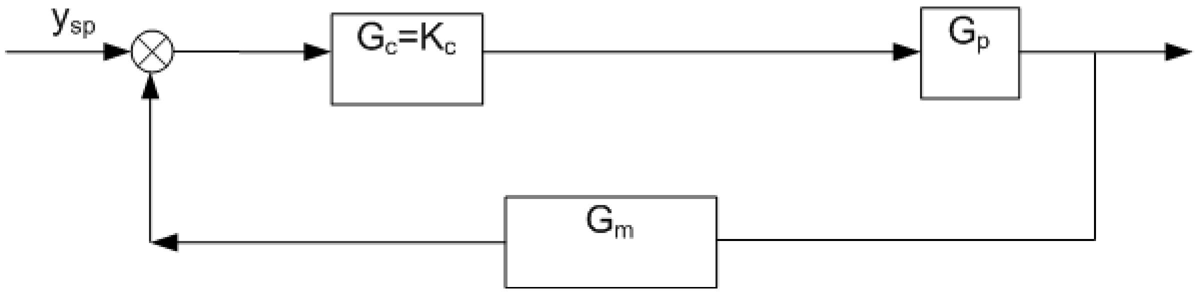
A dynamic process $G_P(s)$ with the following **parameters**:

$$K_p=(3n-0.5)/(3n+0.5)$$

$$tau = \sqrt{2/3}$$

$$zeta=\sqrt{2/5}\ (2n-0.5)/(2n+0.5)$$

has to be coupled with 2 different measuring sensors in a closed loop feedback control.



The 1st sensor has the following transfer function:

$$G_{m1}(s) = (3n-0.5)/(3n+0.5)\frac{1}{s^2+1}$$

The 2nd sensor has the following transfer function:

$$G_{m2}(s) = (3n-0.5)/(3n+0.5)\frac{(s-1)}{(s+1)(s+10)}$$

Initially, K_c=1.

I. Calculate and report here the open loop transfer function $G_{OL1}(s)$ by using $G_{m1}(s)$
II. Calculate and report here the open loop transfer function $G_{OL2}(s)$ by using $G_{m2}(s)$

Part A: *Root locus*

For the **system** $G_{OL1}(s)$:

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 changed

For the **system** $G_{OL2}(s)$:

A.4. Plot the root locus by means of Matlab and SisoTool resources and attach it here
A.5. Calculate the value of the **critical gain** K_c*

A.6. Discuss in detail the closed loop BIBO stability of the system when K_c is changed

On the basis of the above two *Root Loci*

A.7. Discuss which measuring sensor is the most convenient to be adopted with the objective of **closed loop stability**

Part B: Frequency response

For the **system** $G_{OL1}(s)$ and a *P controller with* K_c=1:

B.1 Plot the **Bode Diagrams** by means of Matlab/SisoTool resources, with a *log scale of the magnitude (NOT in dB)*, and attach them here

B.2 Does one or more **resonance frequencies** exist? How much is the value?

B.3 Decide if the Bode stability criterion is applicable

B.4 If yes, is the above system closed-loop stable?

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

Part C: Dynamic responses in the time domain

For the **system** $G_{OL2}(s)$ and a *P controller with* K_c=2.5:

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

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

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

Part D:

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