Politecnico di Torino
Bachelor degree in Electronic and Communication Engineering
***AUTOMATIC CONTROL* – (05LSLLP)**

Surname	**Name**	**id**	**PC**

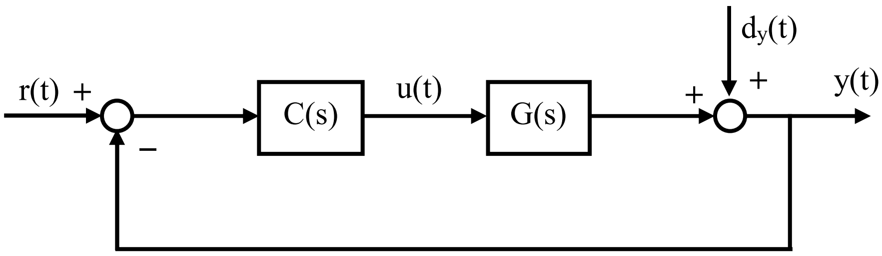
Exam simulation

Part I (6 points)

Solve the proposed exercises and write the answers in the table below. For every correct answer, 3 points are added. For every wrong answer, a penalty corresponding to 1 point is subtracted. Every omitted answer leads to a null score. Please provide the correct numerical computations and/or reasoning needed for the answer (otherwise a null score is given).

Exercise	1	2
Answer		

Exercise 1



In the feedback control system above, we have:

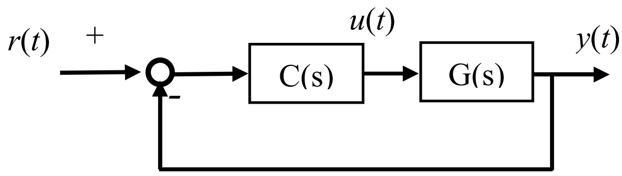
$$G(s) = \frac{1}{s+0.36}, \; C(s) = \frac{0.09}{s}, \; r(t) = 7\varepsilon(t), \; d_y(t) = 0.2\sin(0.6t)\varepsilon(t)$$

Compute the maximum amplitude A_y of the controlled output at steady state.

A) A_y= 0.24284
B) A_y= 7
C) A_y= 7.2428
D) A_y= 7.605

Exercise 2

Given the feedback control system below



with $G(s) = \dfrac{3s+36}{s^2+8s+15}$, $C(s) = \dfrac{14}{s}$.

Compute the analytical expression of the control input $u(t)$ supposing that $r(t) = 0.5\ \varepsilon(t)$.

A) $u(t)$=[-0.11367 $e^{-8.3774\,t}$ + 0.78795 $e^{0.18871\,t}$ cos(7.7541 t - 1.6912) + 0.20833]$\varepsilon(t)$
B) $u(t)$=[-0.22734 $e^{-8.3774\,t}$ + 1.5759 $e^{0.18871\,t}$ cos(7.7541 t - 1.6912) + 0.41667]$\varepsilon(t)$
C) $u(t)$=[-0.11367 $e^{-8.3774\,t}$ + 15.5128 $e^{-0.047331\,t}$ cos(0.39112 t - 1.5465) + 0.20833]$\varepsilon(t)$
D) It is not possible to compute $u(t)$ since the given feedback control system is not stable.

Part II (10 points)

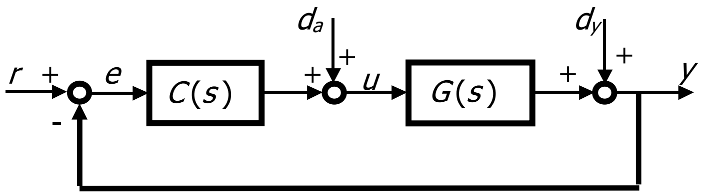
Choose and develop one (only) of the following subjects.

1 - Consider the following transfer function

$$L(s) = 20\frac{s+2}{s(s^2+4)}$$

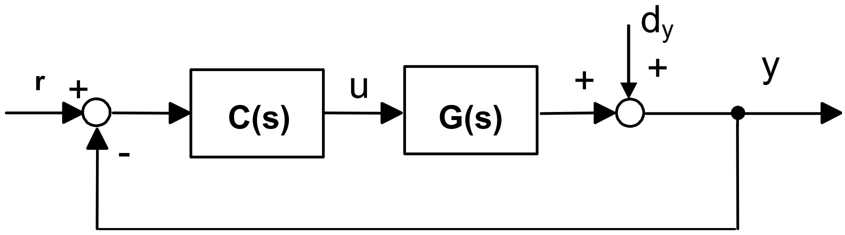
draw by hand the qualitative polar plot of its frequency response. Motivate the obtained result.

2 – State the stability condition for the feedback control system reported below. Then, show that it is not stable if an unstable zero-pole cancellation occurs between the controller numerator and the plant denominator.



Part III (17 points)

Consider the feedback control system below.



where:

$$G(s)=\frac{35.71}{\mathrm{s}^3+155.4\mathrm{s}^2+2009\mathrm{s}},\, d_y(t)=\delta_y\sin(\omega_y t),\left|\delta_y\right|\le 32,\omega_y\le 0.5\,\mathrm{rad/s}$$

Design a controller C(s) in order to meet the following requirements:

- $\left|e_r^\infty\right|=0$ for constant reference signals
- $\left|y_{d_y}^\infty\right|\le 0.8$
- $\hat{S}\le 15\%$;
- $t_{s,5\%}\le 0.18$ s
- $\max_t|u(t)|\le 200$ in the presence of a step reference with amplitude 0.001

At the end of the design evaluate, through time domain simulation, the maximum amplitude of the input signal $u(t)$ in the presence of the disturbance d_y, only

Set MatLab path `>> cd D:\`

Steady state requirements analysis and design (4 points, quit the exercise evaluation in the presence of either a "destabilizing" steady state controller or the wrong type of the control system)

Report the expression of the steady state controller in the form $C_{SS}(s) = \dfrac{K_c}{s^h}, K_c = ..., h = ...$

$C_{SS}(s) =$

Transient and other requirements analysis (2 points)

Design procedure description (5 points)
Please resume and deeply motivate all the design steps performed to obtain the final controller.

Report the expression of the final analog controller in the **dc-gain form**
(e.g. $C(s)=\frac{K_c}{s^r}\frac{1+s/\omega_D}{1+s/(m_D\omega_D)}, K_c=...,r=...,\omega_D=...,m_D=...$, **this is only an example**!!!!)
(**If the expression of C(s) is missing: quit the exercise evaluation. -1 point if provided in the wrong form**

C(s) =

Performance evaluation (5 points)
Use simulation in order to evaluate the achieved performance.
(0,5 each correct evaluation, 0 if the evaluation is wrong or missing
0,5 if the requirement has been satisfied (within 5%),
0 for each unsatisfied requirement with an error > 5%
-0,5 for each unsatisfied requirement with an error > 15%
-1 for each unsatisfied requirement with an error > 30%)

- $\left|y_{d_a}^{\infty}\right|=$
- $\left|y_{d_y}^{\infty}\right|=$
- $\hat{S}=$
- $t_{s,2\%}=$
- $\max_t |u(t)|=$ in the presence of a step reference with amplitude 0.001

Final evaluation after design
(1 point if the evaluation is correct within 10%, 0 point if it is wrong or missing)

$\max_t |u(t)|=$

Save results `>> save Results_AC_s123456 G C`
(-3 if not done)