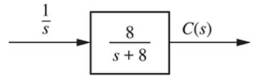
ELEC 372 - Homework 2

(To be submitted on Moodle by July 22nd, 3PM)

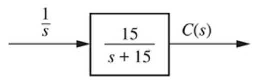
Note:

- By the given deadline, upload a report (in pdf format) containing the solutions to problems below. Late reports will not be accepted.
- For problems solved by hand, include in the report all the steps of the solution.
- For problems requiring the use of Matlab/Simulink, include in the report the obtained results. Upload also the used/developed Matlab and Simlulink files, collecting them in a single zip folder. The uploaded Matlab/Simulink files must be working.
  Plots and figures (e.g., generated in Matlab/Simulink) can be included in the report to better describe/comment the obtained solutions.

Problem 1 (1 points)**.** For each one of the following systems, find an analytic expression for the output $c(t)$. Also compute the time constant, rise time, and settling time (98%).



(*a*)



(*b*)

Problem 2 (1 points)**.** Consider the block scheme in Fig. 1. Compute, by hand, the transfer function between $R(s)$ and $C(s)$

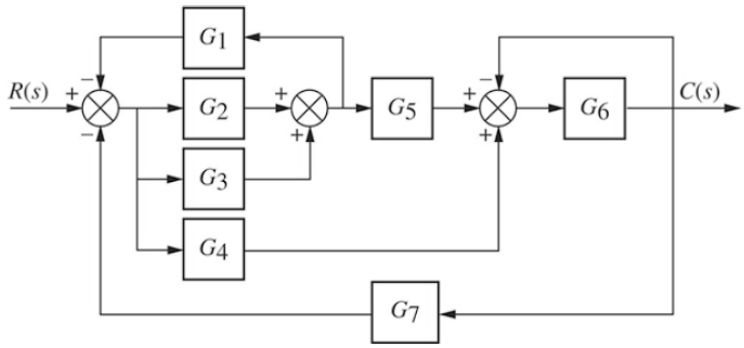


Figure 1: Block scheme

Problem 3 (2 points)**.** Consider the following second-order systems:

$$G_1(s) = \frac{16}{s^2 + 3s + 16}, \quad G_2(s) = \frac{0.04}{s^2 + 0.02s + 0.04}, \quad G_3(s) = \frac{1.05 \times 10^7}{s^2 + 1.6 \times 10^3 s + 1.05 \times 10^7}$$

Consider all the step responses of the above systems and

a) Implement in a Matlab script the formulas to compute $\delta, \omega_n, T_s(98\%), T_p, T_r$ and $\%OS$

b) Find all the parameter computed in point a) using Matlab's Linear System Analyzer.
Hint: open the linear system analyzer typing, in Matlab, the command "ltiview". Type "help ltiview" to learn more about it.

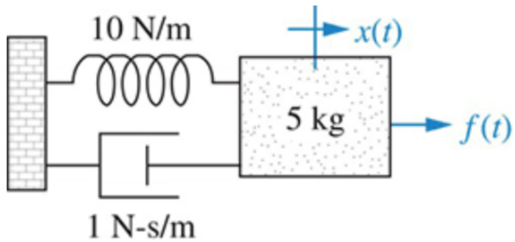
Problem 4 (1 points)**.** Find the location of the poles of second-order systems with the following specifications

a) $\%OS = 15\%$, $T_r = 0.5\,\text{sec}$

b) $\%OS = 8\%$, $T_p = 10\,\text{sec}$

c) $T_s(98\%) = 1\,\text{sec}$, $T_p = 1.1\,\text{sec}$

Problem 5 (3 points). Consider the mass-spring-damper mechanical system shown below



a) Find, using Matlab and by hand, the transfer function $G(s) = \frac{X(s)}{F(s)}$

b) Assuming a unit step as the input, compute $\delta, \omega_n, \%OS, T_s(98\%), T_p, T_r$ and $x(\infty)$

c) Find, using MATLAB's Linear System Analyzer, T_r and $x(\infty)$ and the poles of the transfer function

Problem 6 (2 points)**.** A second-order underdamped system $T(s)$ must fulfill the following specifications for the step response:

- % Overshoot: $\%OS < 5\%$
- Settling time (2%): $T_s < 4\,\text{sec}$
- Peak time: $T_p < 1\,\text{sec}$

In the complex plane, find the region where the poles of $T(s)$ must be in order to achieve the desired response.