EE 4CL4 – Control System Design

Homework Assignment #4

1. The input-output model for a system is given by:

$$\ddot{y}(t) + 7\dot{y}(t) + 12y(t) = 3u(t), \qquad \text{where } \ddot{y}(t) = \frac{\mathrm{d}^2 y(t)}{\mathrm{d}t^2} \text{ and } \dot{y}(t) = \frac{\mathrm{d}\,y(t)}{\mathrm{d}\,t}.$$

   a. Determine the system transfer function.

   b. Compute the unit step response with zero initial conditions.

   c. Repeat with initial conditions $y(0) = -1$ and $\dot{y}(0) = 2$. **(25 pts)**

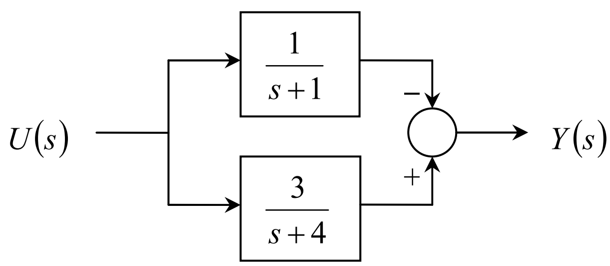
2. Analyze, for $\beta \in \Re$, the frequency response of the AME and the MME when the true and the nominal models are given by:

$$G(s) = \frac{\beta s + 2}{(s+1)(s+2)} \qquad \text{and} \qquad G_o(s) = \frac{2}{(s+1)(s+2)},$$

   respectively.

   Is the AME low-pass, band-pass or high-pass? What about the MME? **(25 pts)**

3. A parallel connection of 2 systems is illustrated by the following block diagram:



   a. What is the transfer function from u to y?

   b. What are the system poles and zero?

   c. Calculate the system step response. How does the system zero influence the shape of the step response? **(25 pts)**

4. Calculate the steady-state responses when a unit step is applied to the following systems, commenting on the differences observed.

$$G(s) = \frac{1}{s^3 + 3s^2 + 3s + 1},$$

   (Hint: you will need to use the Laplace-transform property $\mathcal{L}\left[t^k y(t)\right] = (-1)^k \frac{\mathrm{d}^k\, Y(s)}{\mathrm{d}\, s^k}$ for one inverse Laplace transform)

$$G(s) = \frac{s^2 + 2s}{s^3 + 3s^2 + 3s + 1}.$$

   (25 pts)

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