Objective

To become further acquainted with the MATLAB® Control System Toolbox to synthesize multi-component block models.

Procedure

1. Given the two second-order systems $G_1(s)$ and $G_2(s)$, respectively:

\[
\frac{3s^2 + 2s + 1}{4s^2 + 5s + 8} \quad \text{and} \quad \frac{4s + 2}{s^2 + 2s + 10}
\]

1. Use MATLAB® to create the series connection. Denote this by the Transfer Function “$T(s)$.” Record by sketching a single block diagram.

2. Give both the TF and ZPK forms of this series connection.

3. Plot the unit-step response of $T(s)$.

4. Determine the stability of the series connection.
II. Given the two second-order systems $H_1(s)$ and $H_2(s)$, respectively:

1. Use MATLAB® to create a parallel connection of these two systems. Express the transfer function of the combined system—call it “$D(s)$”—as a ratio of two polynomials.

2. Determine the zeros, poles and gain of $D(s)$.

3. Plot the response of $D(s)$ to the unit-step function.

4. Verify that the instability is not observed when looking at the output of $D(s)$. 
III. Consider the systems described by \(G(s)\) and \(H(s)\), respectively:

\[
G(s) = \frac{3(s + 6)}{(s + 1)(s^2 + 3s + 5)}
\]

\[
H(s) = \frac{5s + 1}{15s + 1}
\]

1. Use MATLAB\textsuperscript{®} to create the negative feedback architecture:

2. Give the closed-loop transfer function —call it “\(Q(s)\)”—as a single ratio of two polynomials.

3. Determine the zeros, poles and gain of \(Q(s)\).

4. Determine the step response of the closed-loop system.