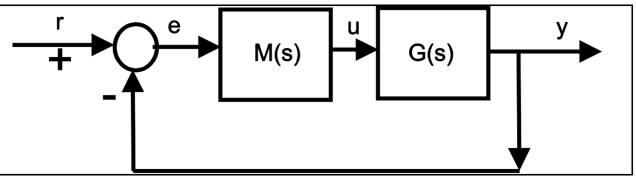
Modelling and control summaries

by Anthony Rossiter

The University Of Sheffield.

Offset and gain tutorial 1

This summary assumes a standard feedback loop and unless specifically stated otherwise, the target r=1. DON'T forget to check stability first!



1. A system output is determined from the following input/system pairs using Y(s)=G(s)U(s), U(s)=L[u(t)]. Find the corresponding steady-state output

$$\left\{\begin{matrix} G(s)=\dfrac{5}{(s+1)} \\ u(t)=2 \end{matrix}\right\} \quad \left\{\begin{matrix} G(s)=\dfrac{0.2}{(s+0.1)(s^2+4s+4)} \\ u(t)=6-e^{-4t} \end{matrix}\right\} \quad \left\{\begin{matrix} G(s)=\dfrac{-3}{(s^2+s+4)(s+0.2)} \\ u(t)=\sin 4t \end{matrix}\right\}$$

$$\left\{\begin{matrix} G(s)=\dfrac{5}{(s+1)(s^2+s+4)(s+2)} \\ u(t)=e^{-2t} \end{matrix}\right\} \quad \left\{\begin{matrix} G(s)=\dfrac{0.2}{(s-0.1)(s^2+4s+4)} \\ u(t)=2+e^{-t} \end{matrix}\right\}$$

$$\left\{\begin{matrix} G(s)=\dfrac{3}{s(s^2+4s+4)(s+2)} \\ u(t)=e^{-2t} \end{matrix}\right\} \quad \left\{\begin{matrix} G(s)=\dfrac{2}{s(s^3+s^2+s+4)} \\ u(t)=e^{-5t} \end{matrix}\right\}$$

ANSWERS in order: 10,3,NA,0,NA,3/16,NA

HINT: You can form Y(s)=G(s)U(s) and apply the FVT directly (if signal is convergent).

2. Find the system steady-state gains

$$G(s)=\frac{2}{s+1}; \quad G(s)=\frac{s+5}{(s+3)};$$

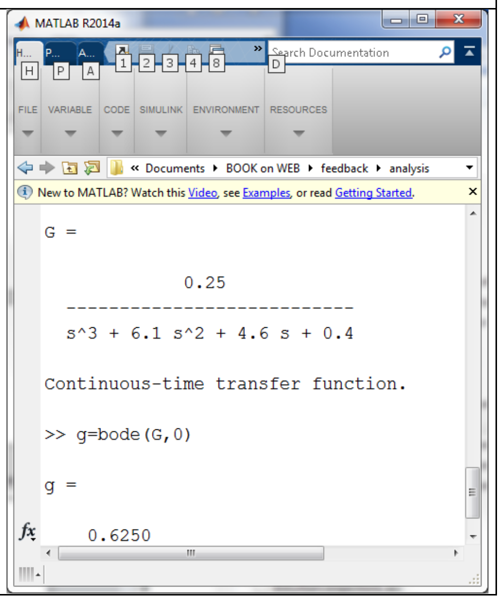
$$G(s)=\frac{s+5}{s(s+3)}; \quad G(s)=\frac{s+2}{s(s+3)(s+1)};$$

$$G(s)=\frac{0.25}{(s+0.1)(s^2+6s+4)}; \quad G(s)=\frac{3(s+5)}{s(s^2+s+4)(s+0.2)};$$

$$G(s)=\frac{2}{s(s^3-s^2+s+4)}; \quad G(s)=\frac{2(s+4)(s+1)}{(s^2+0.1s+2)(s^2+s+4)}$$

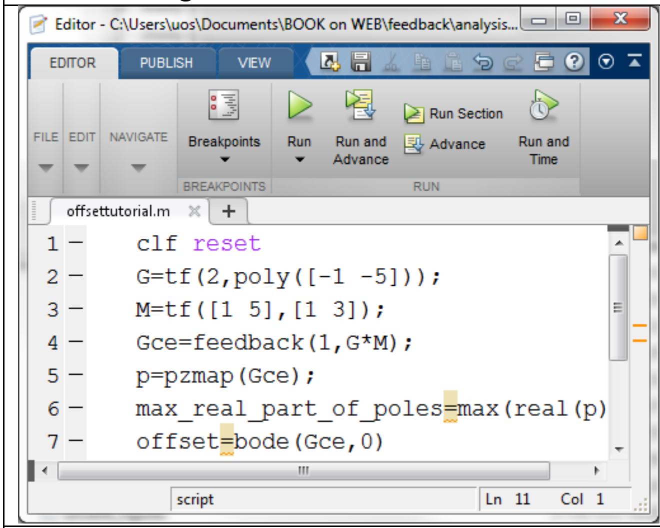
Answers in order: 2,5/3,∞,∞,0.625,∞,∞,1

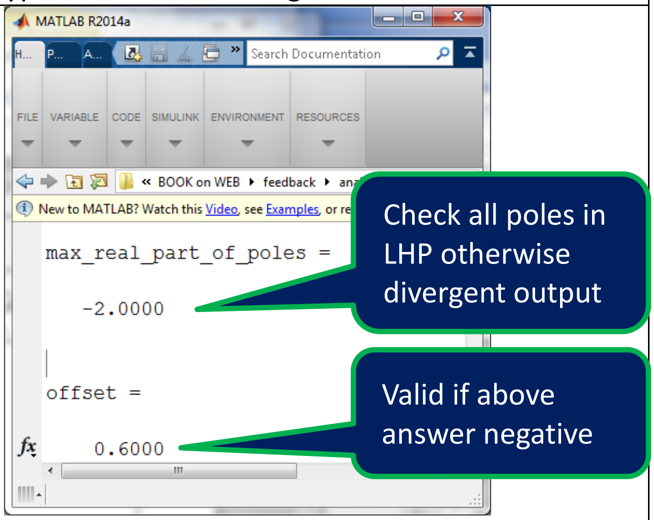
You can check your answers using bode.m in MATLAB as shown here.



3. Find the steady-state offset for the following system/compensator pairs	
$G(s)=\frac{2}{(s+1)(s+5)};\quad M(s)=\frac{s+5}{s+3}$	$G(s)=\frac{6}{s(s+2)(s+4)};\quad M(s)=1$
$G(s)=\frac{2}{(s+4)(s+1)};\quad M(s)=6\frac{s+3}{s+10}$	$G(s)=\frac{6}{(s+2)(s+4)};\quad M(s)=\frac{20}{s}$
$G(s)=\frac{2}{s(s+4)(s+1)};\quad M(s)=6\frac{s+3}{s+10}$	$G(s)=\frac{3s+1}{(s-2)(s+5)};\quad M(s)=\frac{100}{s}$
$G(s)=\frac{6}{(s+2)(s+4)};\quad M(s)=1 \text{ or } 20 \text{ or } 100$	$G(s)=\frac{s-1}{(s+1)(s+2)};\quad M(s)=0.4$
$G(s)=\frac{s+3}{(s+1)(s+5)};\quad M(s)=2$	$G(s)=\frac{2}{(s-1)(s+5)};\quad M(s)=2 \text{ or } 4$
$G(s)=\frac{s+2}{(s+1)(s+4)(s+0.1)};\quad M(s)=3$	$G(s)=\frac{s-5}{(s+1)(s+5)};\quad M(s)=6$
$G(s)=\frac{2}{s^3+0.8s^2+0.2s+0.1};\quad M(s)=3$	$G(s)=\frac{s-1}{s(s+1)(s+5)};\quad M(s)=0.4$
$G(s)=\frac{s+2}{s(s+4)(s+0.1)};\quad M(s)=3$	Are their any clear patterns in your answers?

Checking your answers: Students must be come competent in using tools like MATLAB to reinforce their learning and check numerical answers. Some typical commands are given here.





Use **>>step(Gce)** to plot the response.

This will confirm it is convergent and also allow you to see asymptotic value.