Homework

Steve Mazza

August 5, 2013

Midterm Project

Problem 1

For all of the following, see the attached MATLAB file for the calculation.

(a)

step: 0.6656

ramp: 87.1807

accel: 1.1663e+04

(b)

step: 0.8002

ramp: 19.1654

accel: 7.0527e+03

(c)

step: 3.9954

ramp: 4.4321e+04

accel: 1.9645e+08

(d)

step: 0.8999

ramp: 206.1327

accel: 2.1452e+05

Problem 2

(a)

(b)

(c)

(d)

(e)

(f)

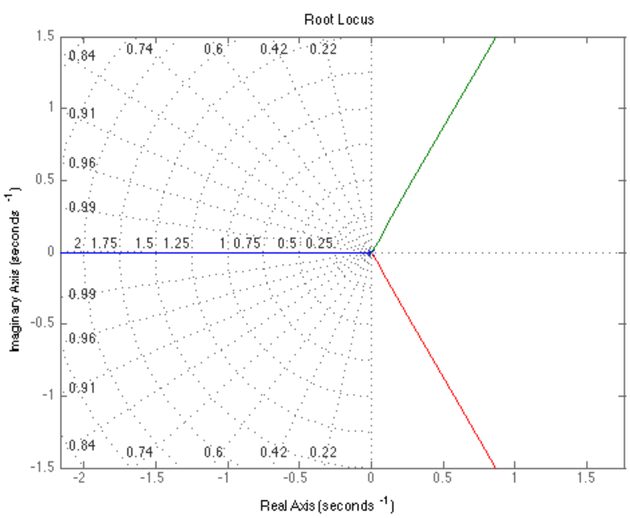
(g)

Homework 7

Problem 1

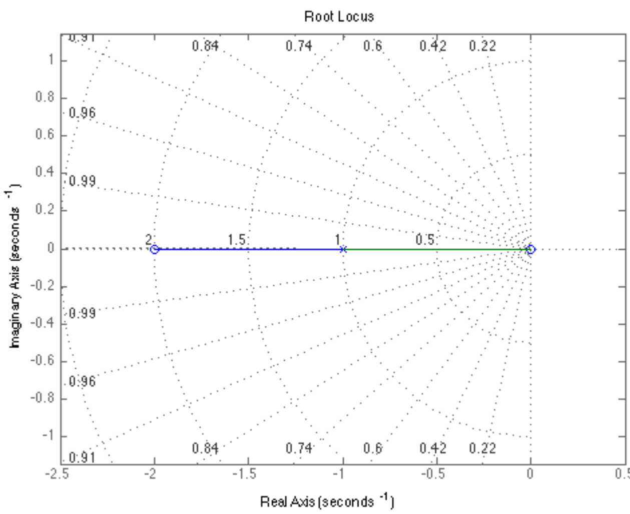
Root-locus plots of the following functions...

(a)



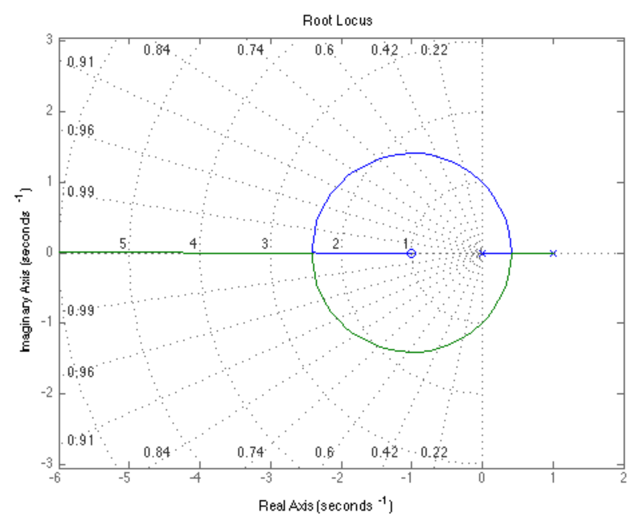
$$G(s) = \frac{1}{(s+0)^3}$$

(b)



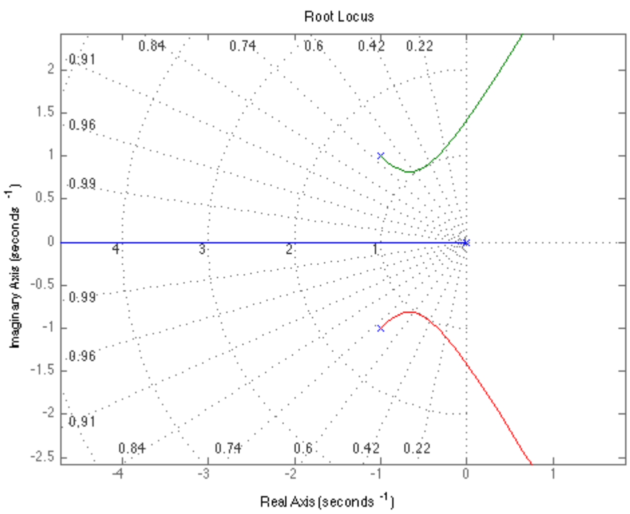
$$G(s) = \frac{(s+0)(s+2)}{(s+1)^2}$$

(c)



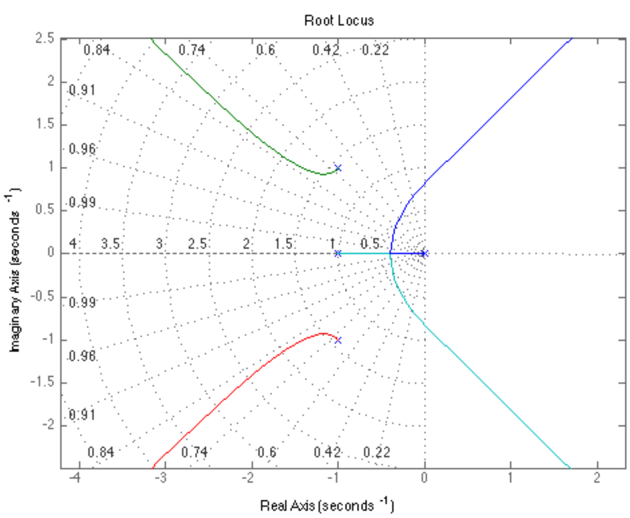
$$G(s) = \frac{s+1}{(s+0)(s-1)}$$

(d)



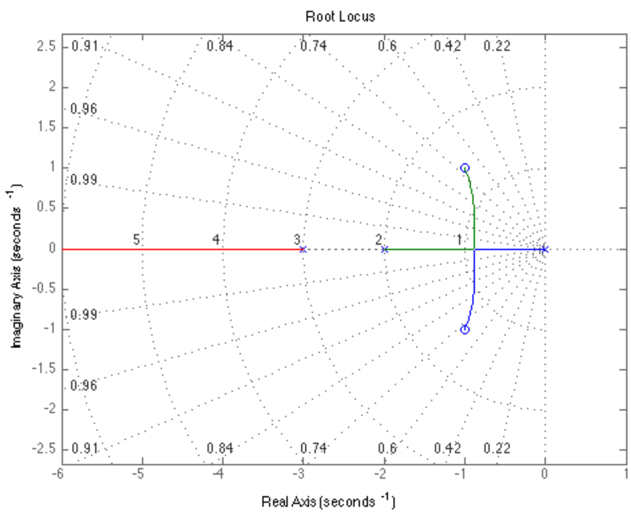
$$G(s) = \frac{1}{(s+0)(s+1+i)(s+1-i)}$$

(e)



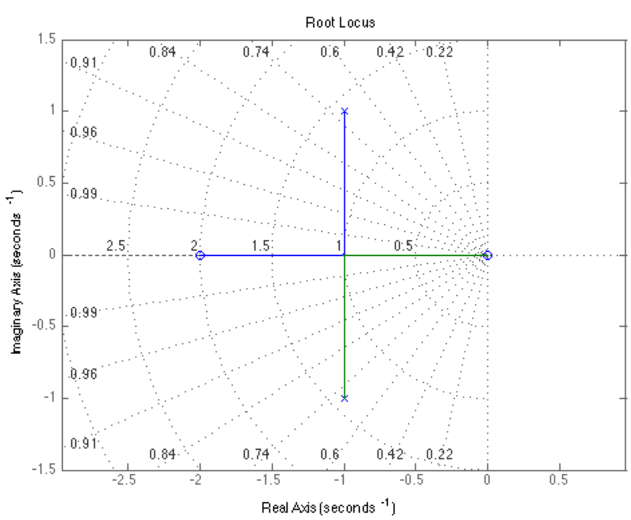
$$G(s) = \frac{1}{(s+0)(s+1+i)(s+1-i)(s+1)}$$

(f)



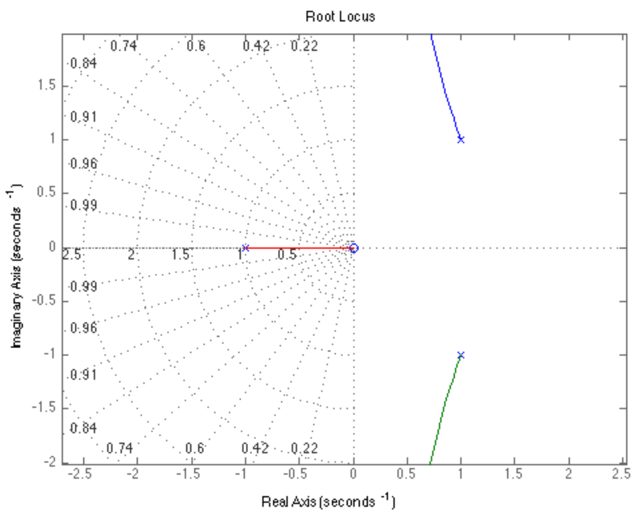
$$G(s) = \frac{(s+1-i)(s+1+i)}{(s+0)(s+2)(s+3)}$$

(g)



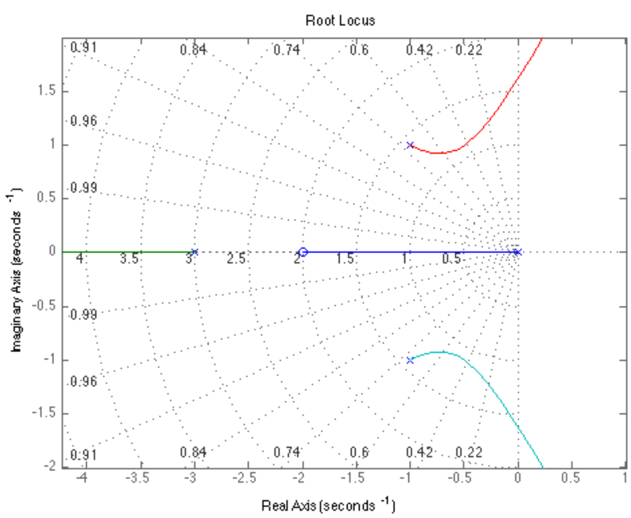
$$G(s) = \frac{(s+0)(s+2)}{(s+1-i)(s+1+i)}$$

(h)



$$G(s) = \frac{(s+0)}{(s+1)(s-1-i)(s-1+i)}$$

(i)



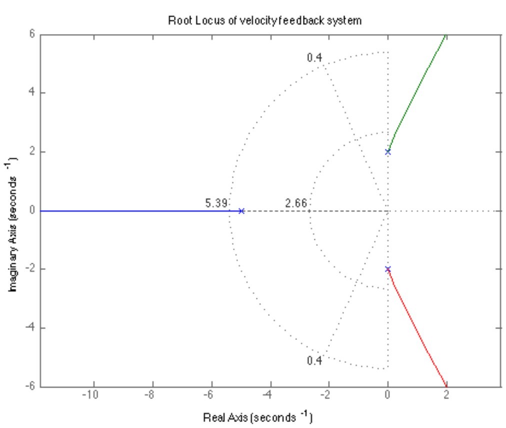
$$G(s) = \frac{(s+2)}{(s+0)(s+3)(s+1-i)(s+1+i)}$$

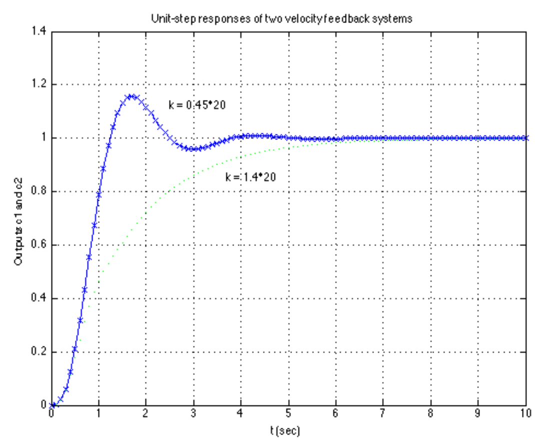
Problem 4

First we apply our reduction rules to the system an derive the open-loop transfer function as follows:

$$
\begin{aligned}
G(s) &= \frac{20}{(s+1)(s+4)} \\
0 &= \frac{\frac{20}{(s+1)(s+4)}}{1 + \frac{20}{(s+1)(s+4)} \times K} \\
0 &= \frac{20}{s^2 + 5s + 4 + 20K} \times \frac{1}{s} \\
0 &= \frac{20}{s^3 + 5s^2 + 4s + 20Ks} \\
\frac{C(s)}{R(s)} &= \frac{20}{s^3 + 5s^2 + 4s + 20 + 20Ks} \\
&= \frac{20}{(s+2i)(s-2i)(s+5) + 20Ks}
\end{aligned}
$$

So we have roots at $\pm 2i$ and -5. I then plug the values that I know into the supplied MATLAB script, `velocity_feedback.m`, and obtain two values for k satisfying $\zeta = 0.4$: $k = 0.45 \times 20$ and $k = 1.4 \times 20$.





Problem 5

Reducing the system, we obtain a transfer function of

$$\frac{K_p + K_d s}{Js^2}$$

Removing the unity feedback, we obtain

$$\frac{K_p + K_d s}{Js^2 + K_p + K_d s}$$

Determine damping ratio, ζ, for maximum overshoot, M_p, given:

$$M_p = e^{-\left(\zeta/\sqrt{1-\zeta^2}\right)\pi}$$
$$0.1 = e^{-\left(\zeta/\sqrt{1-\zeta^2}\right)\pi}$$
$$\zeta \approx 0.826085$$