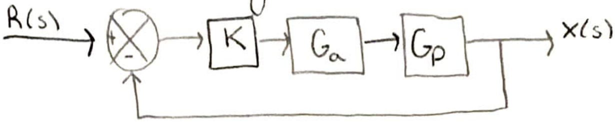
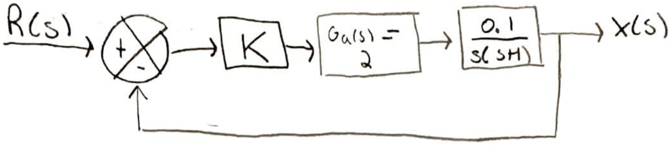
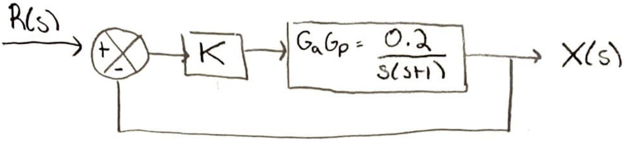
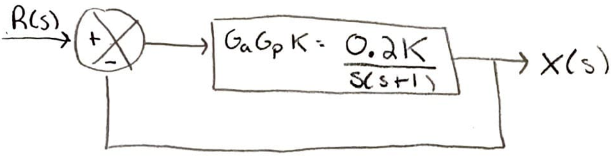
Control Theory CA4

Case 1: Block Diagram









$$OLTF = \frac{X}{E} = \frac{0.2K}{s(s+a)} \qquad CLTF = \frac{C}{R} = \frac{K(2)\left(\frac{0.1}{s(s+1)}\right)}{1+K(2)\left(\frac{0.1}{s(s+1)}\right)}$$

Specifications: 1.) 2nd order system

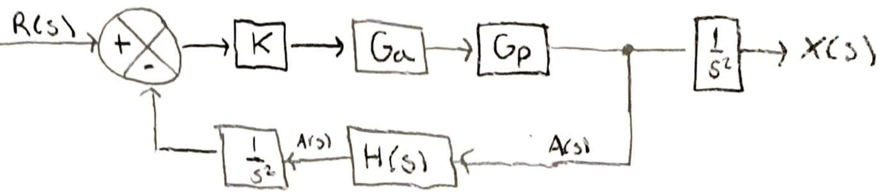
2.) underdamped because it moves quickly to the desired output, so when a lane change is needed the respone is immediate with some overshoot. Furthermore, underdamped systems have less bandwidth and are more practical.

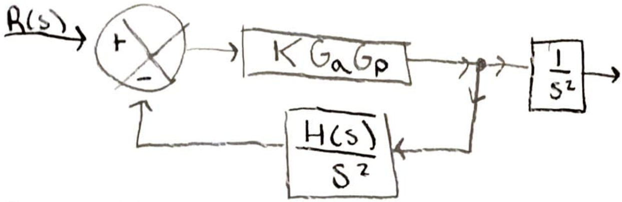
$$\left(\frac{K\left(\frac{0.2}{s(s+1)}\right)}{1+K\left(\frac{0.2}{s(s+1)}\right)}\right)\frac{s(s+1)}{s(s+1)} = \frac{0.2K}{s(s+1)+0.2K} = \frac{0.2K}{s^2+s+0.2K}$$

$\zeta \cancel{<} 1$

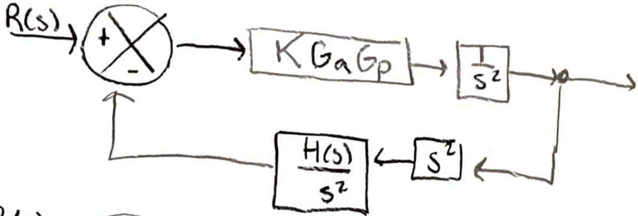
$$2\omega_n\zeta = 1$$
$$\omega_n\zeta = 1/2$$
$$\zeta = 1/2\omega_n$$

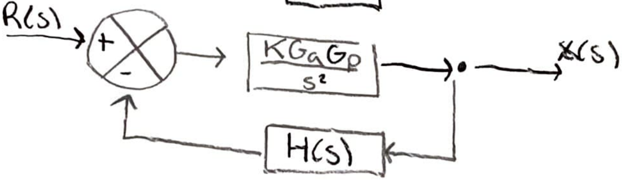
Case 2.

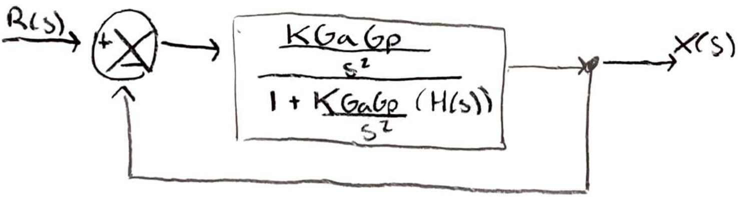


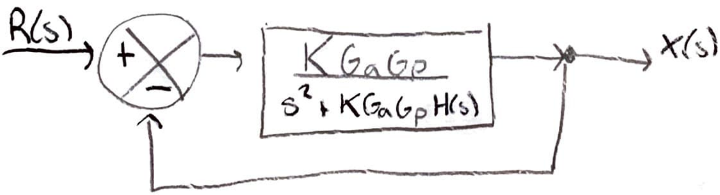


(cascade forms)



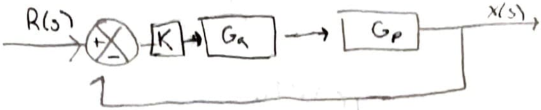




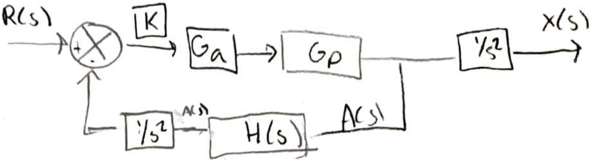


CA4

Case 1



Case 2



$$\frac{\partial^2 x}{\partial t^2} = a$$

$$s^2 x = A$$

hold on → multiple figures on same plot

n = 1, figure (n)

n = n+1 figure (n)

Case 2 OLTF

$K\,G_a G_p H$

$$K\left(\frac{s^2\,0.1}{\cancel{s}(s+1)}\right)(2)\left(\frac{100}{s^2+20s+100}\right)$$

$$\frac{40Ks}{s^3+20s^2+100s+s^2+20s+100} = \frac{40Ks}{s^3+21s^2+120s+100}$$

$$\frac{K(2)\left(\frac{s^2\,0.1}{s(s+1)}\right)}{s^2+K(2)\left(\frac{s^2(0.1)}{s(s+1)}\right)\left(\frac{100}{s^2+20s+100}\right)}$$

$$\frac{\frac{0.2Ks^2}{s^2+s}}{s^2+\frac{20Ks^2}{(s^2+s)(s^2+20s+100}} = \frac{\frac{0.2Ks^2}{s^2+s}}{s^2+\frac{20Ks^2}{s^4+20s^3+100s^2+s^3+20s^2+100s}}$$

$$\frac{\frac{0.2Ks^2}{\cancel{s^2}+s}}{s^2+\frac{20Ks^2}{s^4+21s^3+120s^2+100s}} \quad \frac{(\cancel{s^2}+s)(s^4+21s^3+120s^2+100s)}{1}$$

$$(s^2+s)(s^4+21s^3+120s^2+100s) = \frac{0.2Ks^2(s^4+21s^3+120s^2+100s)}{s^2(s^2+s)(s^4+21s^3+120s^2+100s)+20Ks^2(s^2+s)}$$

$$\frac{0.2K(s^6+21s^5+120s^4+100s^3)}{(s^4+s^3)(s^4+21s^3+120s^2+100s)+20K(s^4+s^3)} = \frac{0.2K(s^6+21s^5+120s^4+100s^3)}{s^8+\cancel{21s^7}+\cancel{120s^6}+\cancel{100s^5}+\cancel{s^7}+\cancel{21s^6}+\cancel{120s^5}+100s^4+20K(s^4+s^3)}$$

$$\frac{0.2K(s^6+21s^5+120s^4+100s^3)}{s^8+22s^7+141s^6+220s^5+100s^4+20K(s^4+s^3)}$$

$$\frac{0.2K\cancel{s^3}(s^3+21s^2+120s+100)}{\cancel{s^3}(s^5+22s^4+141s^3+220s^2+100s+20Ks+1)}$$

~ Symbolab ~

$$\frac{0.2K(s^2+20s+100)}{(s^2+s)(s^2+20s+100)+20K} \to \frac{0.2K(s^2+20s+100)}{s^4+20s^3+100s^2+s^3+20s^2+100s+20K}$$

$$\boxed{\frac{0.2K(s^2+20s+100)}{s^4+21s^3+120s^2+100s+20K}}$$

~ symbolab ~

$$\frac{0.4(s^2+20s+100)}{(s^2+s)(s^2+20s+100)+20} = \frac{0.4s^2+8s+40}{s^4+20s^3+100s^2+20+s^3\,20s^2\,1}$$

$$= \frac{0.4s^2+8s+40}{s^4+21s^3+120s^2+100s+20}$$