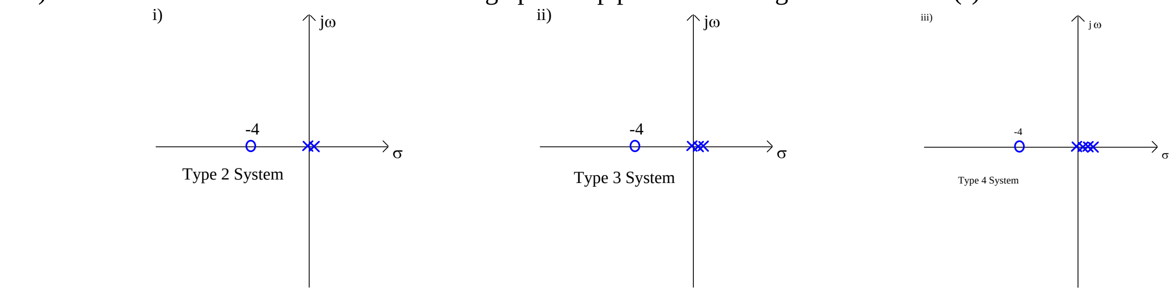
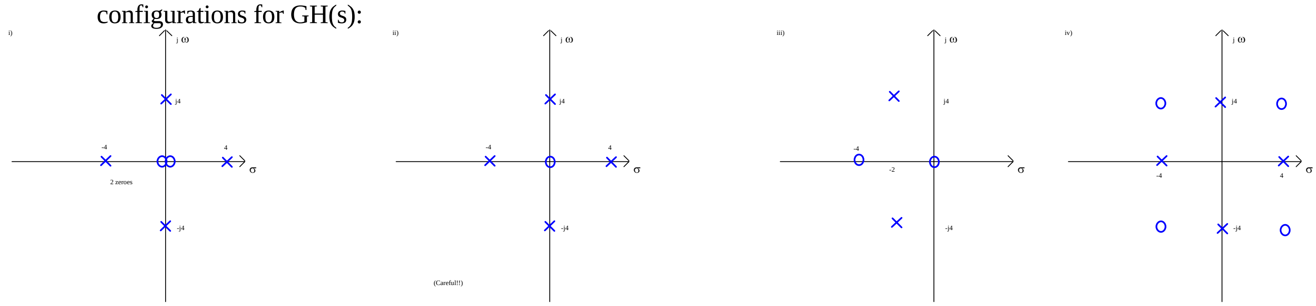
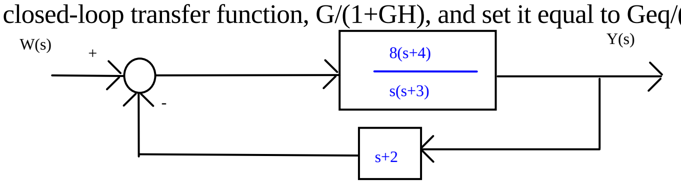
1. a) Sketch the root locus for the following open-loop pole-zero configurations for GH(s):



b) Use the property of symmetry (if applicable) to help you sketch the root locus for the following open-loop pole-zero configurations for GH(s):



2. a) Note that we can still use the error analysis done in class today even if we don't have a unity feedback system by finding an equivalent unity feedback system, Geq/(1+Geq), that produces the same closed-loop transfer function. Then, we can just use Geq to determine system type, ess, etc. Find Geq for the following NON-UNITY feedback system (hint: find the closed-loop transfer function, G/(1+GH), and set it equal to Geq/(1+Geq) and solve for Geq)

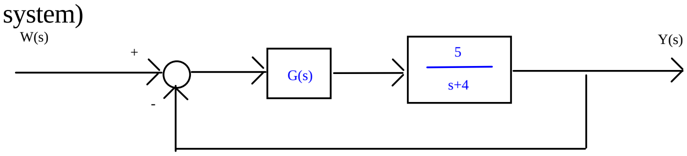


b) Find the type number, Kp, Kv, Ka, and $ess|_{step}$ $ess|_{ramp}$, and $ess|_{parabola}$ for the following unity feedback systems with i) G(s)=5(s+2)/[s(s+4)] ii) G(s)=5(s+2)/[$(s+4)^2$] iii) G(s)=5(s+2)/[s^2(s+4)]

c) Suppose I used the input w(t)=10u(t)+2r(t) to the unity-feedback systems described in part 2b). What is the new steady-state error (Remember what Kyle Buchanan said in class about linearity!)?

d) Suppose I used the input w(t)=10u(t)+20u(t-3)+2r(t)+5r(t-8) to the unity-feedback systems described in part 2b). What is the new steady-state error (be careful)?

e) For the system shown below, design the simplest compensator possible so that the following system has $ess|_{step}$ < 1/10 and a settling time of less than 0.1 seconds and NO OVERSHOOT. (Hint: Try Gc(s)=K and sketch root locus. Find a K that meets both the transient and ess specs. Note that your closed-loop system is a simple 1st order system and not a classic second-order system)



f) Repeat part e) with the specs that $ess|_{step}$ = 0 and the closed-loop poles s= -2+j and -2-j. (Hint: Recall that inserting an integrator (1/s) increases the system type number by one. Think about what the minimum system type you need to meet ess specs and lump the 1/s term in with G(s) and sketch the new root locus. If the root locus of G(s)/s passes thru the point s1=-2+j, then use the magnitude condition to find the appropriate K. Gc(s) would then be K/s)

g) What is the settling time and percent overshoot for the compensated system in 2f)?