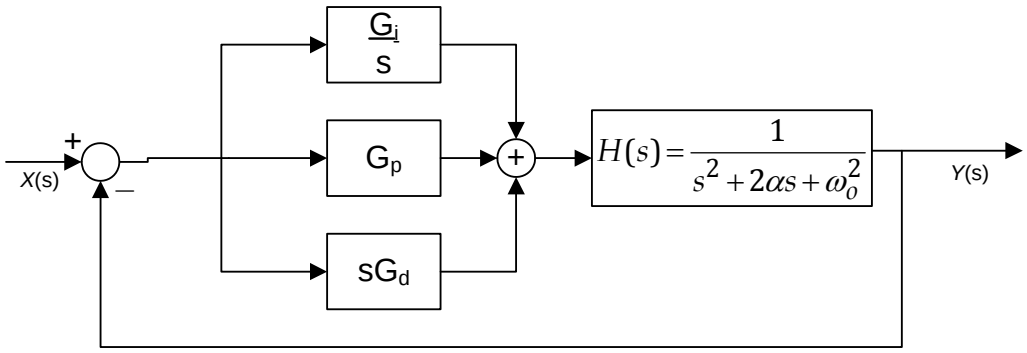
Homework 2
Due Monday, November 1

1) Given the following PID-controlled system…



Show that the transfer function for the controlled system is…

$$\frac{Y(s)}{X(s)} = \frac{G_D\, s^2 + G_P\, s + G_I}{s^3 + (2\alpha + G_D)s^2 + (\omega_0^2 + G_P)\, s + G_I}$$

2) A pole-zero plot can be used to show the effect of gradual variation of the PID constants in a control system. Suppose that H(s) in problem 1 is replaced with the following transfer function, representing a conditionally stable system:

$$H(s) = \frac{1}{s^2 + 9}$$

Suppose also that the proportional and integral gains are set to zero, creating a differential-only feedback control system.

a) Using MATLAB or another plotting program, plot the location of the system's poles as the differential gain G_D is increased from zero to ten. The resulting plot is called a root locus.

b) At what value of G_D do the two poles start moving in opposite directions?

c) Will increasing the differential gain cause the system to become unstable?

d) For G_D=4, plot the step response and estimate the resulting values of percent overshoot, peak time, and settling time. Compare these to the values calculated using the formulas provided in lecture.

Just for fun: Plot the system overshoot (if any), rise time and 2% settling time vs. G_D.