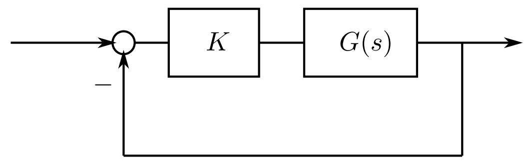
EE363 Automatic Control: Homework #4

1) *Root locus.* Sketch the root loci of the following systems for $K > 0$, to the reasonable accuracy of the departure angles and the asymptotes with the centers.



a) $G(s) = \dfrac{1}{s(s+1)}$

b) $G(s) = \dfrac{s+2}{s(s+1)}$

c) $G(s) = \dfrac{1}{s(s+1)(s+2)}$

d) $G(s) = \dfrac{s+2}{s^2(s+20)}$

e) $G(s) = \dfrac{s+2}{s^2(s+3)}$

f) $G(s) = \dfrac{1}{s(s-1)}$

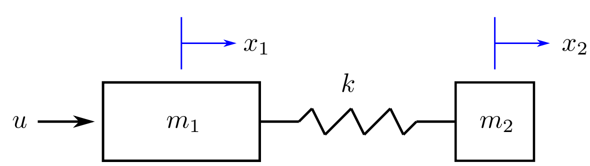
g) $G(s) = \dfrac{s+2}{s(s-1)}$

h) $G(s) = \dfrac{s-1}{(s-2)(s+10)}$

i) $G(s) = \dfrac{s-1}{(s-2)(s-3)(s+10)}$

j) $G(s) = \dfrac{(s+0.5)(s+1.5)}{s(s^2+2s+2)(s+5)(s+15)}$

2) *Collocated vs. noncollocated systems.* Consider the following two masses of m_1 and m_2 connected by a stiff spring k, with control force u acting on m_1. Say, $m_1 = 10$, $m_2 = 1$, and $k = 100$.



a) Suppose we have a position sensor mounted on m_1, *i.e.*, your actuator and sensor are *collocated*. Find the transfer function $G_{\mathrm{c}}(s)$ describing the dynamics from u to x_1.

b) Suppose we have a position sensor mounted on m_2, *i.e.*, your actuator and sensor are *noncollocated*. Find the transfer function $G_{\mathrm{nc}}(s)$ describing the dynamics from u to x_2.

c) Show that a simple PD controller can stabilize $G_{\mathrm{c}}(s)$. Also, check if the same holds for $G_{\mathrm{nc}}(s)$. Hint. Sketch the root loci of the two plants with a simple PD control.