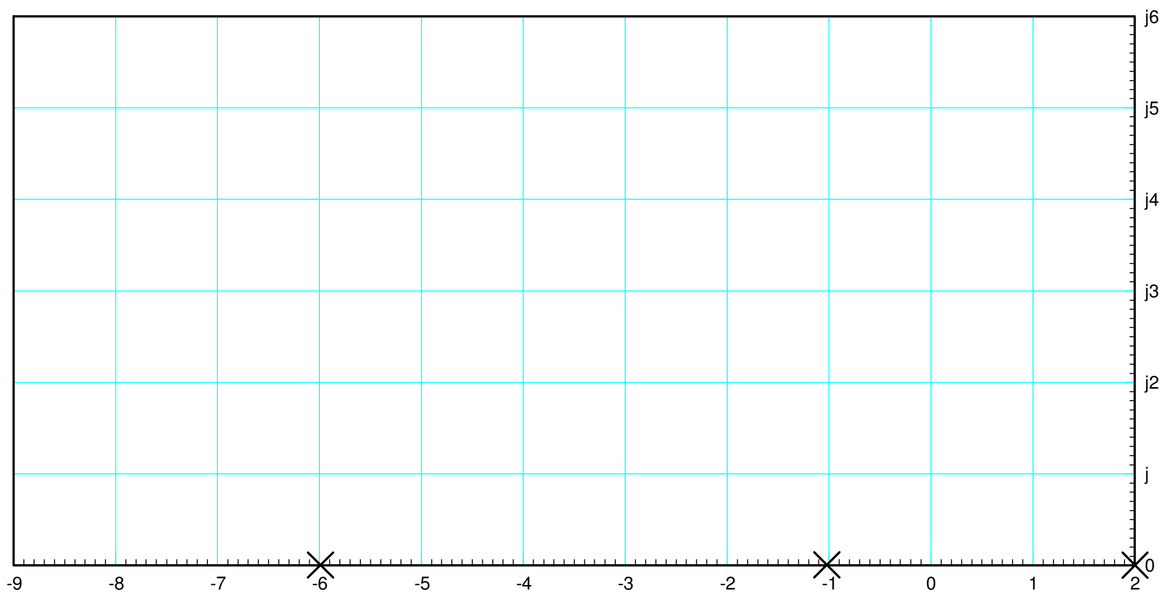
ECE 461/661: Handout #28

Unstable Systems

Design a gain compensator, K(s), so that the following system is

- Closed-loop stable,
- With 2% settling time of 5 seconds

$$G(s) = \left(\frac{20}{(s-2)(s+1)(s+6)}\right)$$



Solution

There are multiple solutions.

Design a gain compensator, K(s), so that the following system is

- Closed-loop stable,
- With 2% settling time of 5 seconds

$$G(s) = \left(\frac{20}{(s-2)(s+1)(s+6)}\right)$$

Translation: Place the real part of the dominant pole at

s = -4/5 + jX

Let

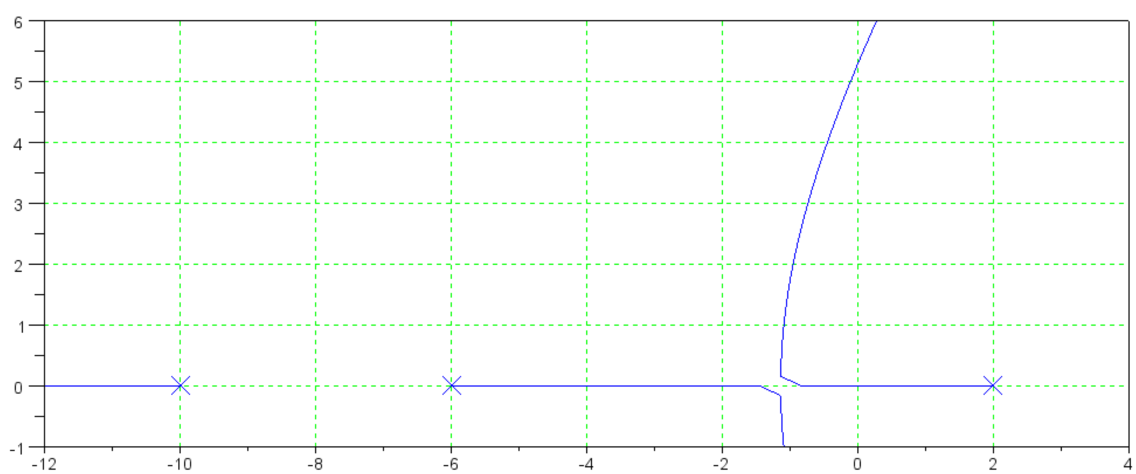
$$s = -0.8$$

You can't cancel the pole at s = +2, so cancel the pole at s = -1

$$K(s) = k\left(\frac{s+1}{s+10}\right)$$

$$GK = \left(\frac{20}{(s-2)(s+6)(s+10)}\right)$$

This results in the breakaway point being s = -1.139, which is left of s = -0.8. This will work.



Pick k to place the closed-loop dominant pole at s = -0.8

$$\left(\frac{20}{(s-2)(s+6)(s+10)}\right)_{s=-0.8} = -0.149$$

$$k = \frac{1}{0.149} = 6.698$$

resulting in

$$K(s) = 6.698\left(\frac{s+1}{s+10}\right)$$

checking in matlab

```
G = zpk([],[2,-1,-6],20);
K = zpk(-1,-10,6.698);
Gcl = minreal(G*K / (1 + G*K));
zpk(Gcl)


              133.96
------------------------------
(s+1.488) (s+0.8011) (s+11.71)
```