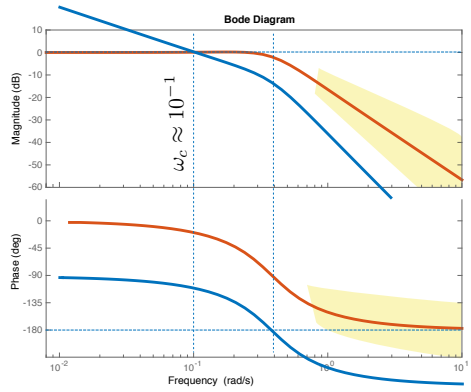
$$G_c(s) = \text{PI}(s) = K\,\frac{s+z}{s}$$

K: to set crossover frequency z: to reduce phase lag

Recall "I" design from lecture: 1

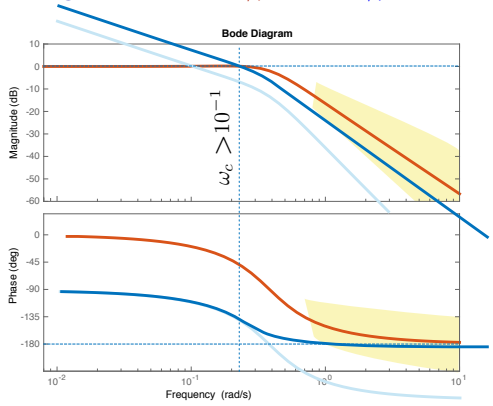
Design: Bode Plot $\Delta\omega/\rho$ *and* $\Delta\omega/\rho \times$ ***"I"***



90 degree phase lag
from integral control

New design with PI 2

Design: Bode Plot $\Delta\omega/\rho$ *and* $\Delta\omega/\rho \times$ ***PI***

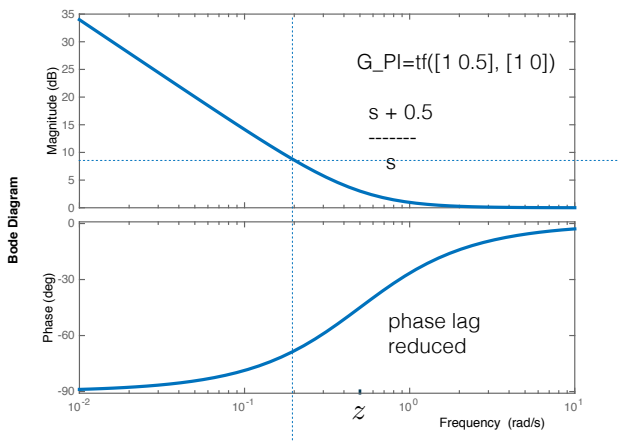


Blue plot above is the goal
for a new design.

To achieve this:
Introduce the zero in the PI compensator
to remove phase lag at high frequencies

PI design 3

Bode Plot



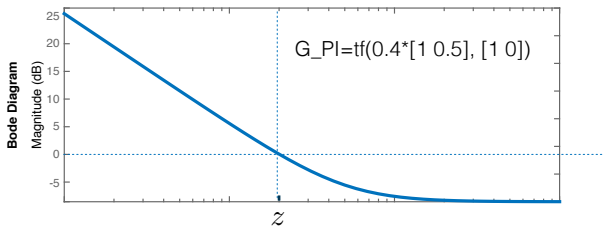
Example with $z = 0.5$ and $K = 1$

$\omega_c > 10^{-1}$ 4

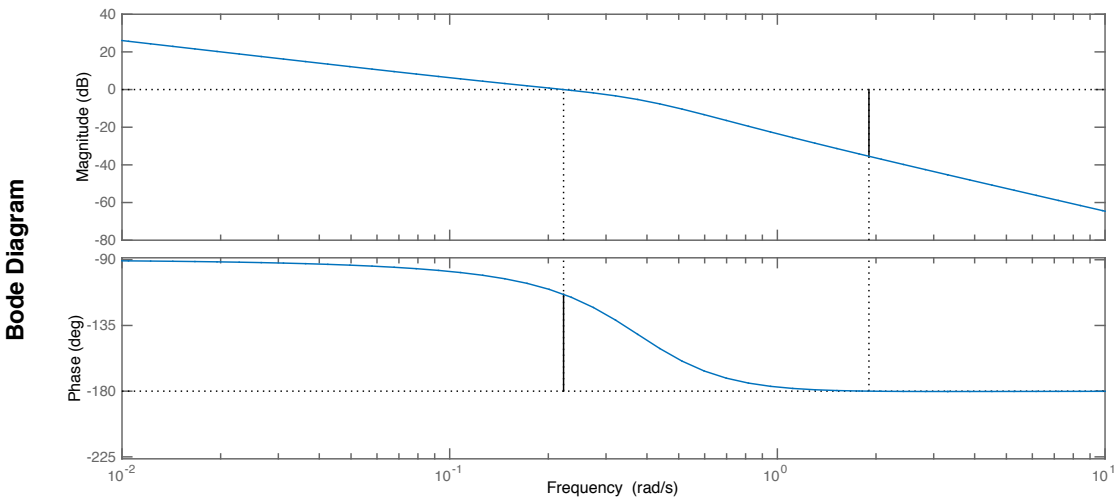
Suppose we want to double the crossover frequency

With K=1, we see on the right that the gain of the PI compensator is about 8dB at this frequency.

Set K = -8db (K about 0.4) to obtain this:



Bode Plot for Final Design: $\Delta\omega/\rho \times$ ***PI*** 5

margin(tf(1,dengrid)*G_PI)

Gm = 35.4 dB (at 1.9 rad/s) , Pm = 66.4 deg (at 0.223 rad/s)