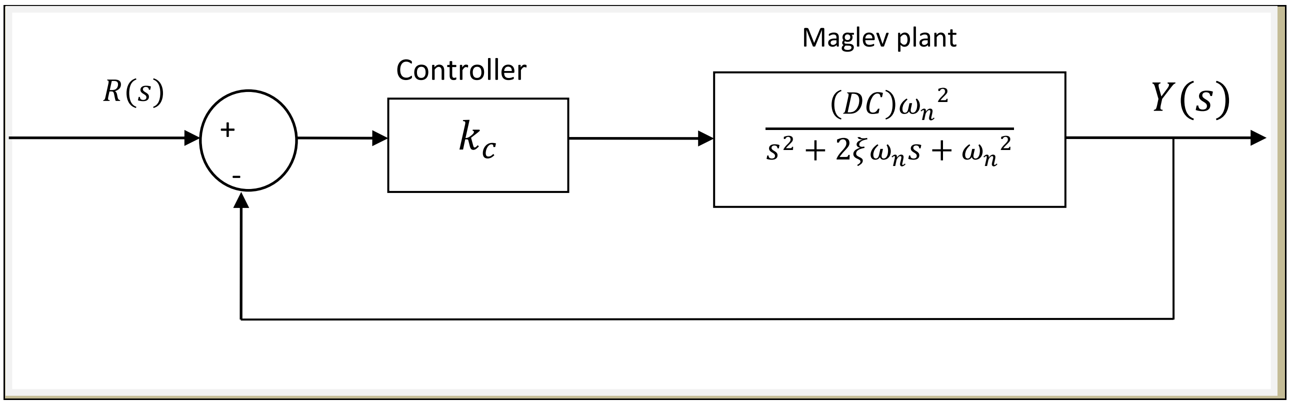
Theory

The closed loop block diagram for P control of Maglev system is shown in below figure



From the figure, the closed loop transfer function (CLTF) can be derived as

$$CLTF = \frac{Y(s)}{R(s)} = \frac{K_c(DC)\omega_n^2}{s^2+2\xi\omega_n s+\omega_n^2(1+K_c(DC))} \ , \qquad (1)$$

Let us design P controller to place the closed loop poles at $-a' \pm jb'$.

The desired denominator of closed loop is

$$(s+a'+jb')(s+a'-jb') = s^2+2a's+a'^2+b'^2 \ , \qquad (2)$$

Compare the denominator of CLTF in (1) with (2):

$$s^2+2\xi\omega_n s+\omega_n^2\big(1+K_c(DC)\big) = s^2+2a's+\left({a'}^2+{b'}^2\right),$$

From the above equation, we see that the real part of the closed loop poles is given by

$$a' = \xi\omega_n \ , \qquad (3)$$

which is fixed for a given maglev plant.

Also,

$$\mathrm{a}'^2 + \mathrm{b}'^2 = \omega_n^2\left(1 + \mathrm{K_c}(\mathrm{DC})\right) \quad \Longrightarrow \quad K_c = \frac{\left(\dfrac{a'^2 + b'^2}{\omega_n^2} - 1\right)}{DC} \ ,$$

Giving

$$K_c = \frac{\left(\frac{\xi^2\omega_n^2 + b'^2}{\omega_n^2} - 1\right)}{DC} \ . \tag{4}$$