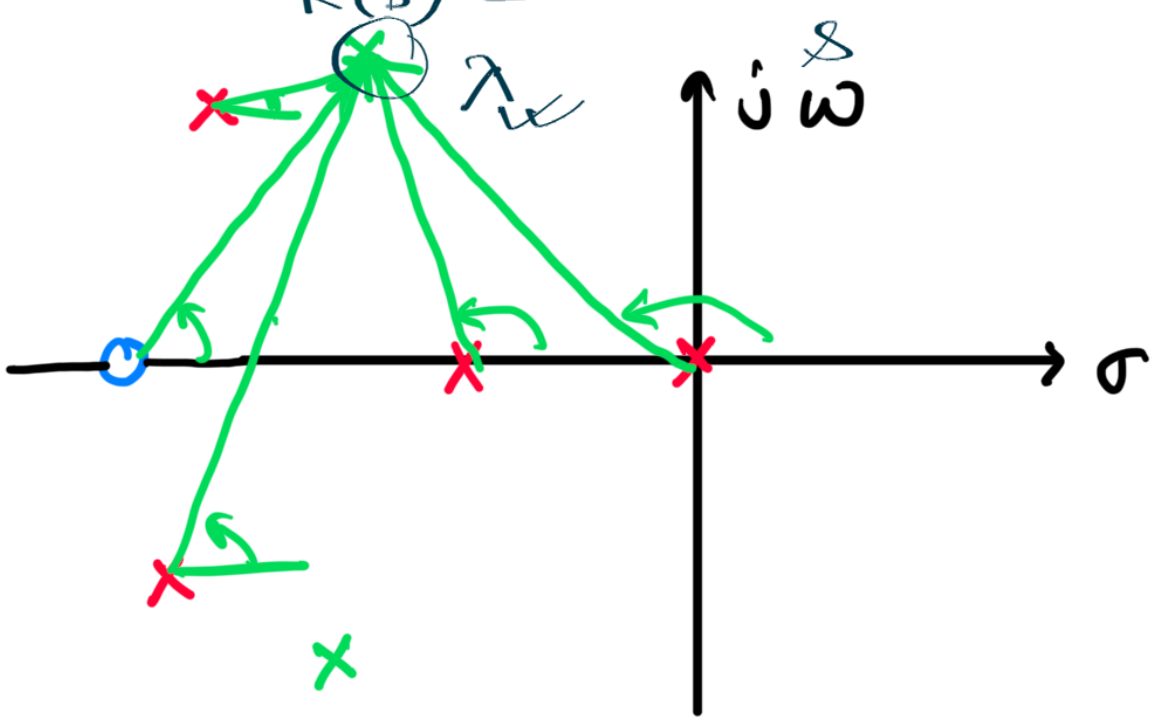
30 March:

$$G(s) = \frac{1}{s^3 + 4s^2 + 6s + 2}$$

$$K(s) = \frac{K(s+a)}{s}$$

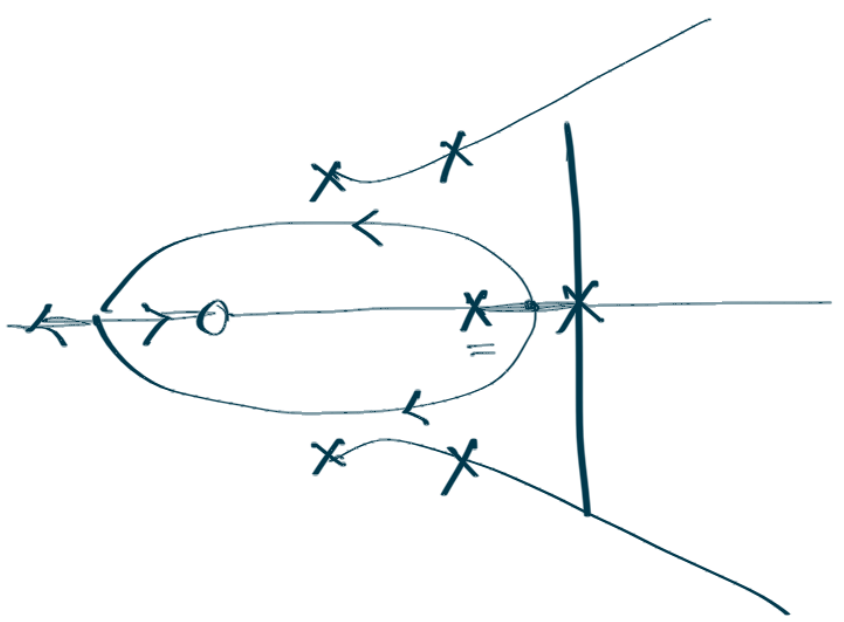


Use angle criterion to find out "a".

Because λ_1 has to be a closed-loop pole,

$$1 + K\frac{(\lambda_1 + a)}{\lambda_1} \cdot \frac{1}{(\lambda_1^3 + 4\lambda_1^2 + 6\lambda_1 + 2)} = 0$$

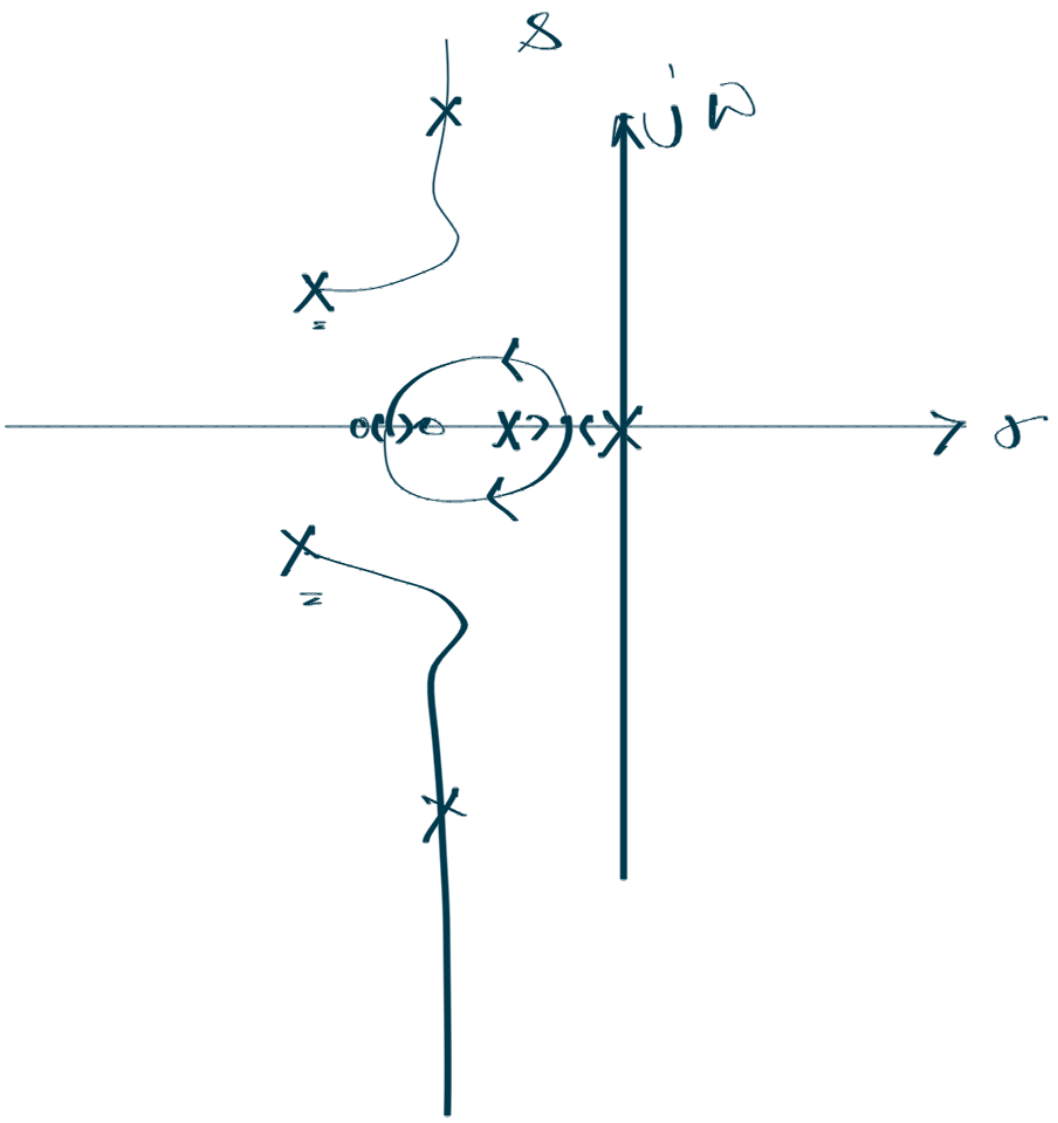
$$\Rightarrow K = \left| \frac{\lambda_1(\lambda_1^3 + 4\lambda_1^2 + 6\lambda_1 + 2)}{(\lambda_1 + a)} \right|$$



PID controller:

$$K(s) = K_p + \frac{K_I}{s} + K_D s = \frac{K_p s + K_I + K_D s^2}{s}$$

$$= K(s+a)(s+b)$$



(b) PD controller:

$$K(s) = K_p + K_D s = K(s+a)$$

$$|K(j\omega)| = |(K_p + K_D j\omega)|$$

$$= (K_p^2 + K_D \omega^2)^{\frac{1}{2}}$$