The role of zeros.

- In most of our design examples, $L(s) = G(s)H(s)$ has had no finite zeros; ie

$$G(s)H(s) = \frac{P(s)}{Q(s)} = \frac{K}{Q(s)}$$

- In practice, many systems will have zeros, and these will affect the transient performance of the system and the shape of the root locus

- However, the effects of zeros are more subtle than those of poles. In particular, if we do a partial fraction expansion

$$T(s) = \sum_k \frac{A_k}{s - d_k}$$

each pole affects only one term
each zero affects all A_k.

$$A_k = (s - d_k)\, T(s) \Big|_{s = d_k}$$

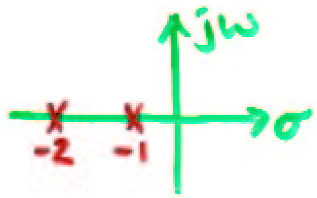
In particular, if $T(s)$ has a zero near d_k, A_k will be small

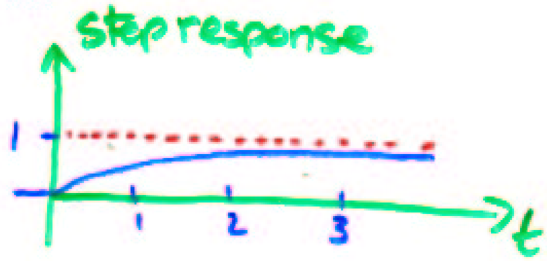
Zeros and the step response

- Zeros can have a substantial impact on the step response, as we show in this example

- Consider a second-order overdamped system

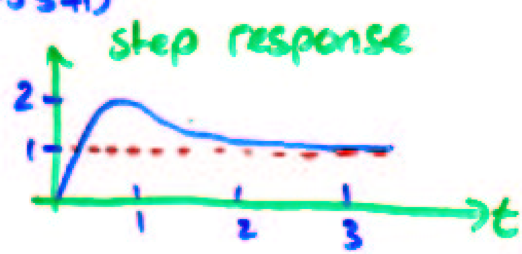
$$T_1(s) = \frac{1}{(s+1)(0.5s+1)}$$





- Now add a zero at $s = -1/4$

$$T_2(s) = \frac{1+4s}{(s+1)(0.5s+1)}$$



OVERSHOOT!

- What if the zero were at $s = 1/4$.

$$T_3(s) = \frac{1-4s}{(s+1)(0.5s+1)}$$

UNDERSHOOT!