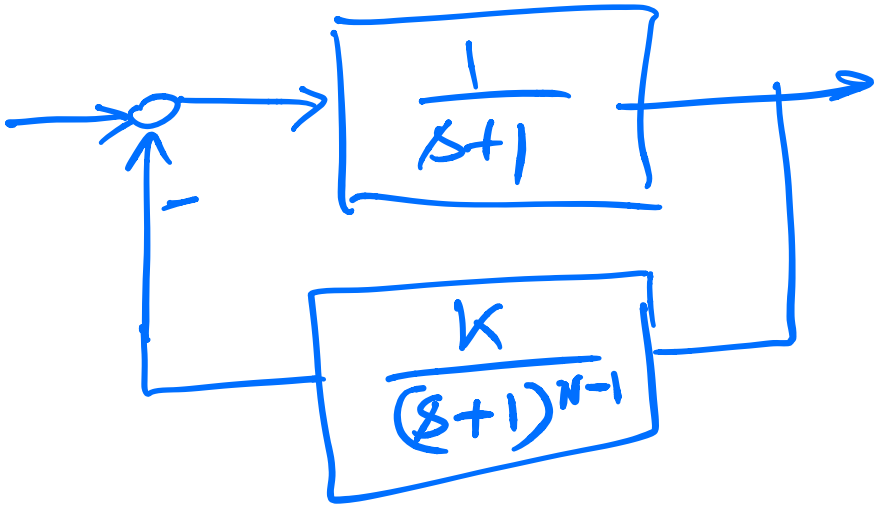
ELL 707

10.02.2020



Feedback sign is (for $K > 0$)

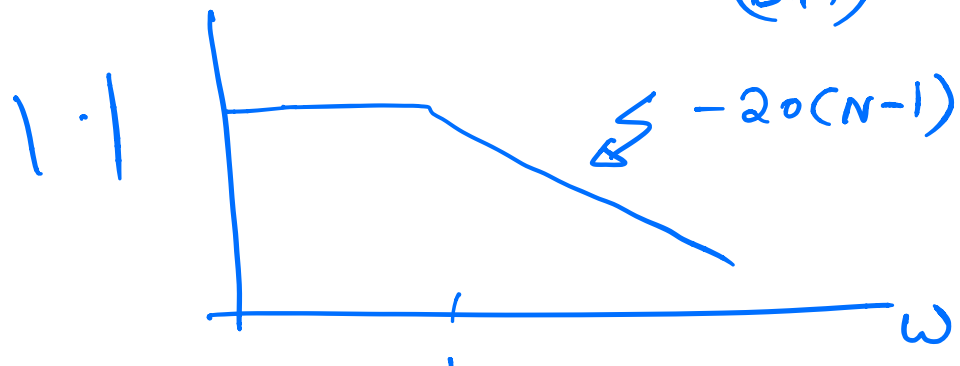
a) Positive

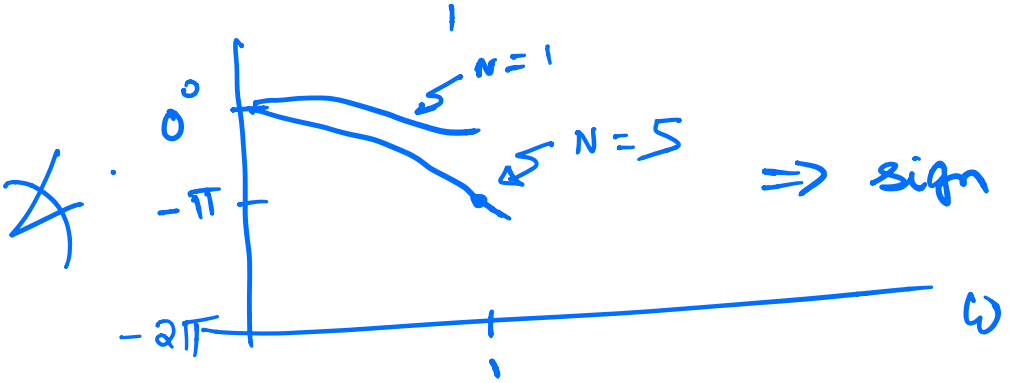
b) Negative ~5

c) Both / depends

d) None of the above / not sure ~2

Freq. response of $\frac{K}{(s+1)^{N-1}}$, $s = j\omega$

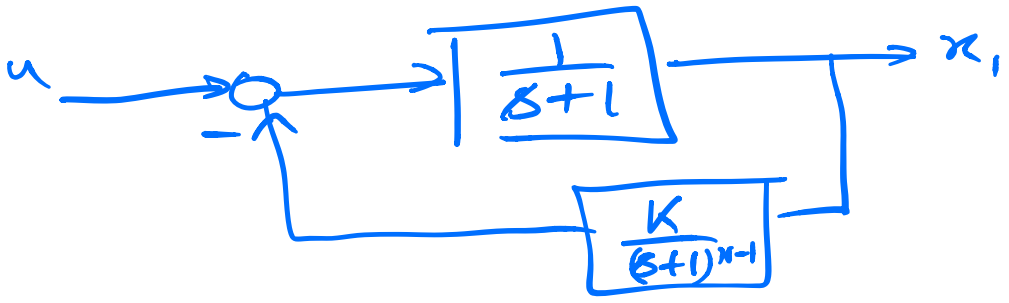




$-(N-1)\tan^{-1}(\omega)$

$\Rightarrow$ sign of feedback changes with frequency.

Q4



upto N=3 in minor test 1.

a) what happens when N = 4? does it still have imaginary eigenvalues?

b) what happens when there is a pure delay say e^{-Ts} in the feedback path? (N = 1)

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a) $(s+1)^4 + K = 0$

$s = j\omega$, $\rightarrow$ $s^4 + 4s^3 + 6s^2 + 4s + 1 + K = 0$

$\rightarrow$ $\omega^4 - 4j\omega^3 - 6\omega^2 + 4j\omega + 1 + K = 0$

Re $\quad \omega^4 - 6\omega^2 + 1 + K = 0$ $\qquad K = 4$

Im $\quad -4\omega^3 + 4\omega = 0 \Rightarrow \omega = 0, 1$

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b) $D(s) = (s+1) + Ke^{-Ts} = 0$

(1) $\frac{1 - Ts}{1 + Ts}$ ✗ Padé approximate

$s = j\omega$ $\quad j\omega + 1 + K\cos\omega T - jK\sin\omega T = 0$

$\Rightarrow \quad K\cos\omega T = -1$

$\omega = K\sin\omega T$

$\Rightarrow$