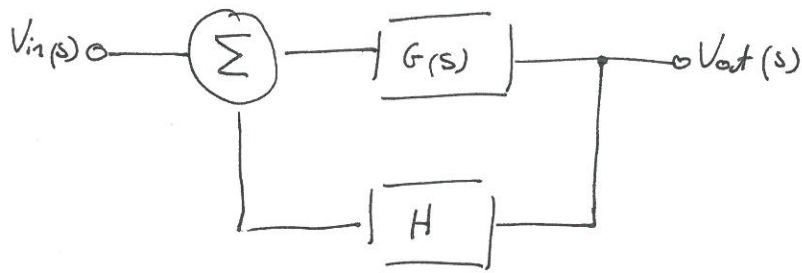


Q: How CAN A 2nd-ORDER SYSTEM HAVE A RHP POLE?

• CLOSED LOOP TRANSFER Fxn:



$$\rightarrow H_{cl}(s) = \frac{G(s)}{1 + H(s)G(s)} = \frac{G(s)}{1 + H_{ol}(s)} \dots (1)$$

• OPEN LOOP TRANSFER Fxn:

$$H_{ol}(s) = \frac{A(0)}{(s - p_{ol1})(s - p_{ol2})} \dots (2)$$

• p_{ol1}/p_{ol2} = OPEN LOOP POLES

• p_{ol1}/p_{ol2} & LIE IN LHP AS OPEN LOOP SYSTEM IS STABLE

• SUBSTITUTION (2) INTO (1) GIVES THE CLOSED LOOP CHARACTERISTIC EQUATION, WHOSE ROOTS ARE THE CLOSED LOOP POLES.

$$\rightarrow 1 + H_{ol}(s) = 1 + \frac{A(0)}{(s - p_{ol1})(s - p_{ol2})} = \frac{(s - p_{ol1})(s - p_{ol2}) + A(0)}{(s - p_{ol1})(s - p_{ol2})}$$

$$= s^2 - s(p_{ol1} + p_{ol2}) + p_{ol1}p_{ol2} + A(0) \dots (3)$$

• ROOTS OF (3) ARE:

$$p_{cl1}/p_{cl2} = \frac{-(p_{ol1} + p_{ol2}) \pm \sqrt{(p_{ol1} + p_{ol2})^2 - 4(p_{ol1}p_{ol2} + A(0))}}{2}$$

$$\Rightarrow \mathcal{R}(s) = \frac{-(p_{ol1} + p_{ol2})}{2} \dots \text{ALWAYS -VE i.e. IN THE LHP.}$$

\Rightarrow IF p_{ol1}/p_{ol2} ARE ALWAYS -VE (LHP):

\Rightarrow HOW CAN 2nd-ORDER CLOSED LOOP POLES EXIST IN RHP??