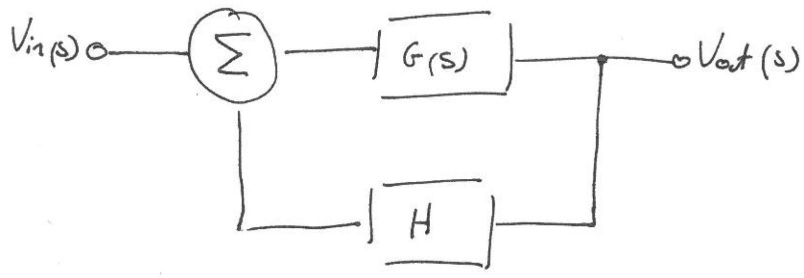
Q: HOW CAN A 2ND-ORDER SYSTEM HAVE A RHP POLE?

• CLOSED LOOP TRANSFER FXN:



$$\Rightarrow H_{CL}(s) = \frac{G(s)}{1+H\,G(s)} = \frac{G(s)}{1+H_{OL}(s)} \quad \ldots (1)$$

• OPEN LOOP TRANSFER FXN:

$$H_{OL}(s) = \frac{A(0)}{(s+p_{OL1})(s+p_{OL2})} \quad \ldots (2)$$

• p_{OL1}/p_{OL2} = OPEN LOOP POLES

• p_{OL1}/p_{OL2} LIE IN LHP AS OPEN LOOP SYSTEM IS STABLE

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

$$\Rightarrow 1+H_{OL}(s) = 1+\frac{A(0)}{(s+p_{OL1})(s+p_{OL2})} = (s+p_{OL1})(s+p_{OL2}) + A(0)$$

$$= s^2 + s(p_{OL1}+p_{OL2}) + p_{OL1}p_{OL2} + A(0) \quad \ldots (3)$$

• ROOTS OF (3) ARE:

$$p_{CL1}/p_{CL2} = \frac{-(p_{OL1}+p_{OL2}) \pm \sqrt{\left[(p_{OL1}+p_{OL2})^2 - 4(p_{OL1}p_{OL2}+A(0))\right]}}{2}$$

$\Rightarrow$ $\Re(s) = \frac{-(p_{OL1}+p_{OL2})}{2}$ ... ALWAYS −VE i.e. IN THE LHP.

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