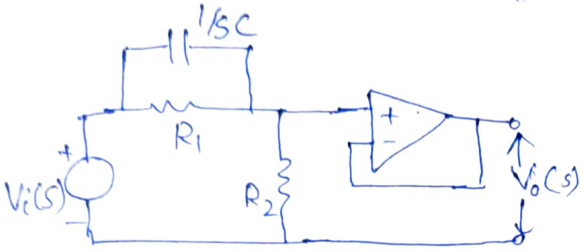
Lead / Lag Compensator using Op-Amp

Op-Amp Lag Compensator

→ A lag compensator adds a pole to the system & is used to improve the steady state response of the system.

→ A lag compensator provides phase lag (negative phase) in the freq. response of system.



Op-Amp Lead Compensator

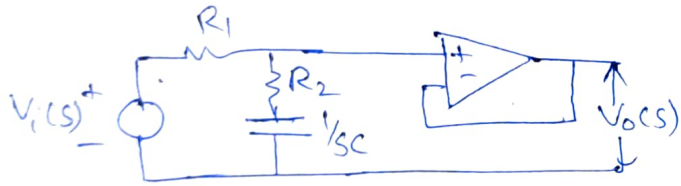
$$V_o(s) = V_i(s) \cdot \frac{R_2}{R_2 + \frac{R_1 \cdot 1/sC}{R_1 + \frac{1}{sC}}}$$

$$\frac{V_o(s)}{V_i(s)} = \frac{R_2(1+sCR_1)}{R_2(1+sCR_1)+R_1}$$

→ Hence the phase added to the system is

$$\tan^{-1}(\omega C R_1) - \tan^{-1}\left(\omega C \frac{R_1 \cdot R_2}{R_1+R_2}\right)$$

→ Since $R_1 > \frac{R_1 R_2}{R_1+R_2}$, phase added is positive (phase lead)



Op-Amp Lag Compensator

$$V_o(s) = V_i(s) \cdot \frac{R_2 + \frac{1}{sC}}{R_1 + R_2 + \frac{1}{sC}}$$

$$\frac{V_o(s)}{V_i(s)} = \frac{sCR_2+1}{sC(R_1+R_2)+1}$$

→ Hence phase added to the system is

$$\tan^{-1}(\omega C R_2) - \tan^{-1}(\omega C(R_1+R_2))$$

→ Since $R_2 < R_1+R_2$, phase added is negative (phase lag)

Op-Amp Lead Compensator

→ A lead compensator adds a zero to the system & is used to improve transient response of the system.

→ A lead compensator provides phase lead (positive phase) in the freq. response of the system.