Compensator

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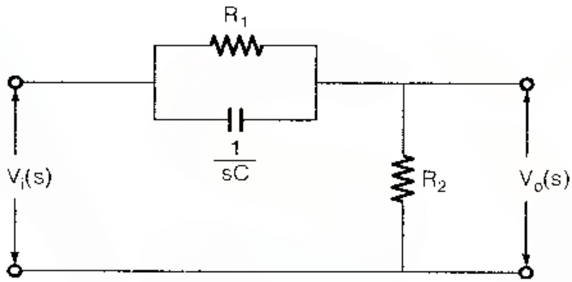
Compensator in control system are used for improving the performance specifications i.e. the transient and steady state response characteristics.

Lead Compensator



$$\boxed{\frac{V_o(s)}{V_i(s)} = \frac{\alpha(1+Ts)}{(1+\alpha Ts)}}$$

where, $\boxed{T = R_1 C}$ and $\boxed{\alpha = \frac{R_2}{R_1 + R_2}}$ $(\alpha < 1)$

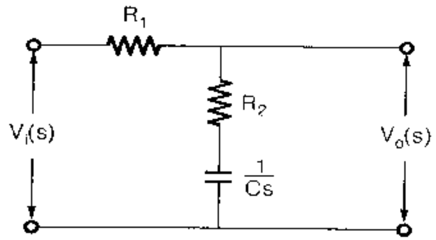
Note:

- **Zero is closer to origin than the pole.**
- **It is similar to the PD controller.**

Effect of Lead Compensator

1. It improves the transient response.
2. It increases the margin of stability.
3. It increases the bandwidth.
4. $\left(\frac{\text{Signal}}{\text{Noise}}\right)_{\text{output}} < \left(\frac{\text{Signal}}{\text{Noise}}\right)_{\text{input}}$
5. It helps to increase error constant upto some extent.
6. It allows to pass high frequencies and low frequencies are attenuated.
7. Increase the phase shift.

LAG Compensator



$$\boxed{\frac{V_o(s)}{V_i(s)} = \frac{1+Ts}{1+\beta Ts}}$$

where, $\boxed{T = R_2 C}$ and $\boxed{\beta = \frac{1}{\alpha} = \frac{R_1 + R_2}{R_2}}$ $(\beta > 1)$

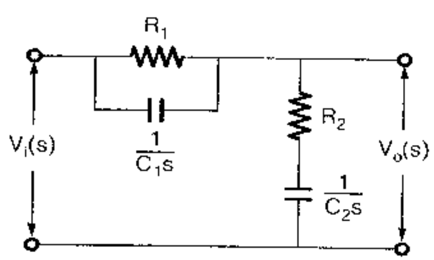
Note:

- Pole is closer to origin than the zero.
- It is similar to the PI controller.

Effect of Lag Compensator

1. It improves the steady state response.
2. It increases the error constant.
3. It decreases the bandwidth.
4. It reduces the effect of noise.
5. It reduces the stability margin.
6. It does not affect the transient response.
7. System become lesser stable.
8. It allows to pass low frequencies and attenuates the high frequencies.
9. Decreases the phase shift.

Lead-LAG/LAG-Lead Compensator



$$\boxed{\frac{V_o(s)}{V_i(s)} = \frac{\alpha(1+T_1 s)(1+T_2 s)}{(1+\alpha T_1 s)(1+\beta T_2 s)}}$$

where, $\boxed{T_1 = R_1 C_1}$ and $\boxed{T_2 = R_2 C_2}$

$\boxed{\alpha = \frac{R_2}{R_1 + R_2}}$ and $\boxed{\beta = \frac{R_1 + R_2}{R_2}}$

Effect of lead-lag/lag-lead compensator

Lead-Lag network improves both steady state and transient response of the system.

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