Active Realization

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Shaping Circuits (EEC 242), 2015

Outline

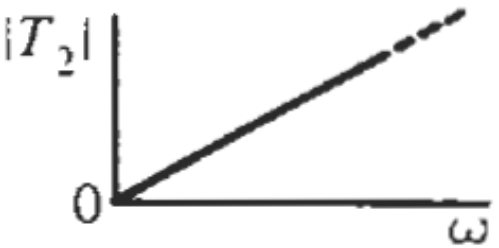
Passive realization disadvantages

Active Realization

- Inverting Op Amp circuits
- Non-inverting Op Amp circuits
- Differential OpAmp

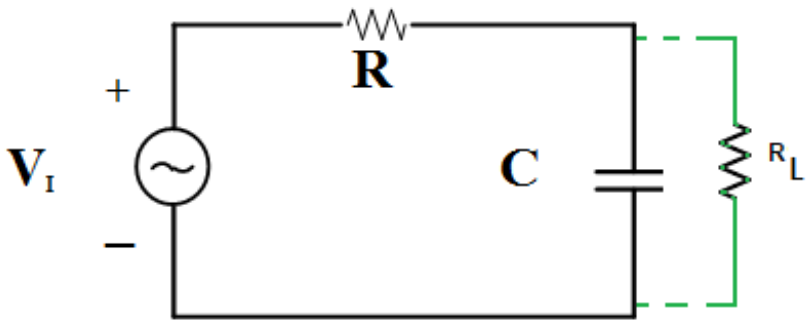
Transfer Function

- Not all transfer functions could be realized (ex. $\frac{K_1}{S}$)

$T_n(S)^a$	Pole and Zero	Magnitude Response	Phase Response
$\frac{K_1}{S}$			
K_2S			

Loading disadvantage

- Loading problems.
- The gain always≤ 1.

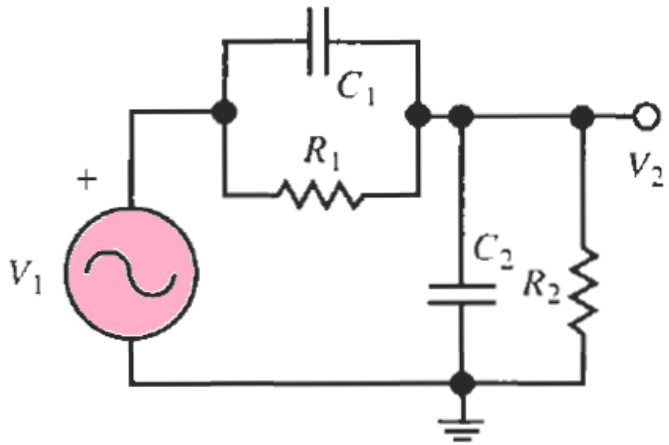


$$\frac{V_o}{V_i} = \frac{1}{1 + SRc} = \frac{1}{1 + j\omega Rc}$$

$$\frac{V_o}{V_i} = \frac{R_L}{R_L + R} \frac{1}{\left(S \frac{R_L Rc}{R_L + R} + 1\right)}$$

Dependency between zeros and poles

Fixing incorrect zeros due to component tolerance through fabrication process will affect the poles of the TF.



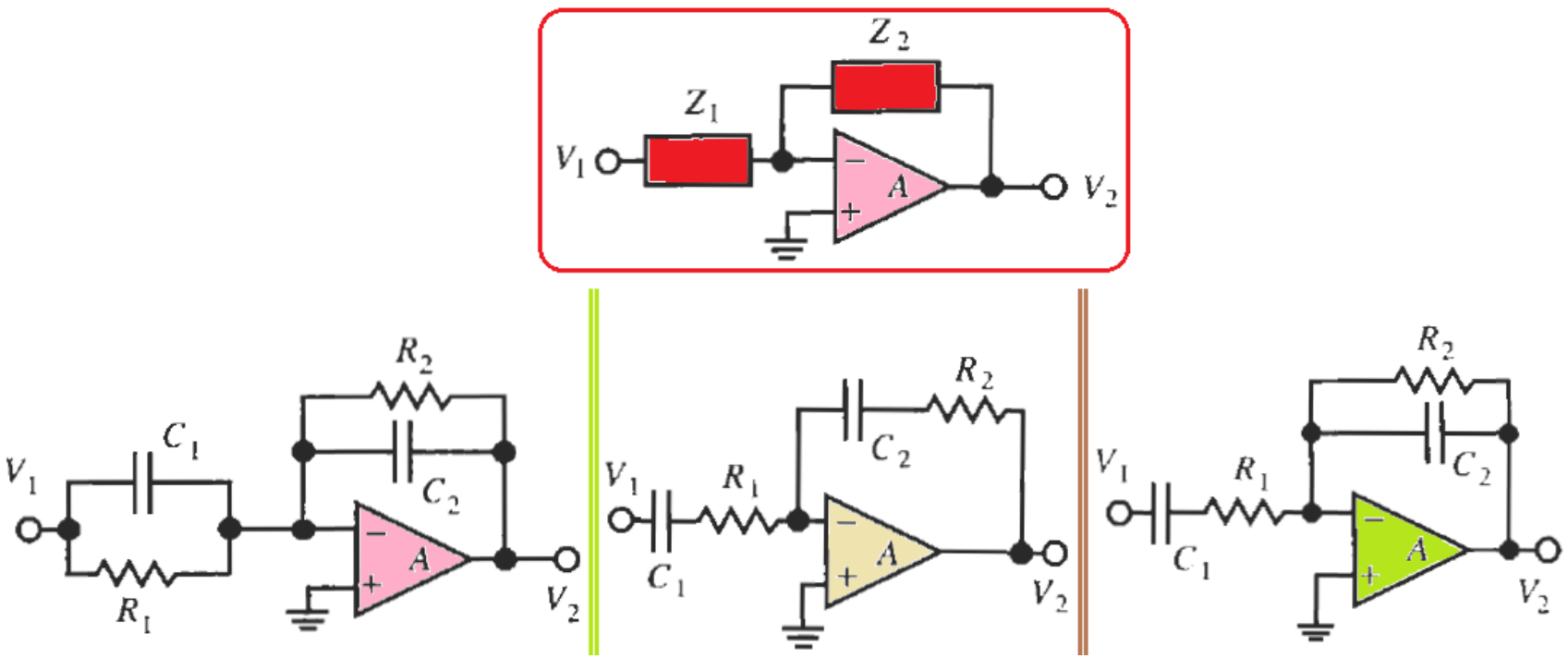
$$|T(S)| = K\frac{s+z}{s+p}$$

$$z = \frac{-1}{R_1 C_1}$$

$$p = \frac{-1}{\left(\frac{R_1 R_2}{R_1+R_2}\right)(c_1+c_2)}$$

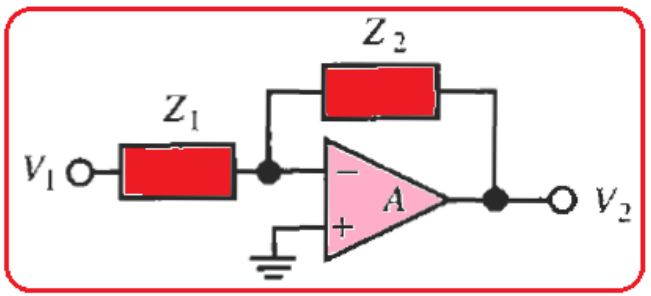
Different toplogies single Equation

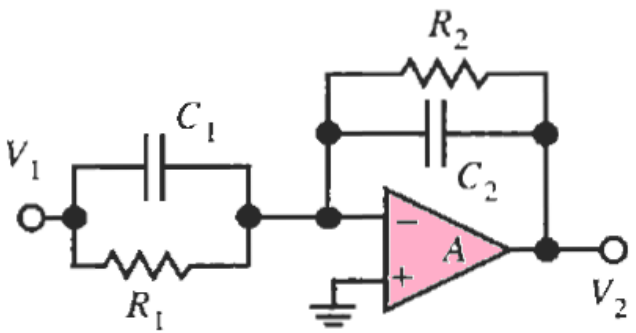
$$|T(S)| = -\frac{Z_2}{Z_1} = -K\frac{S+z_1}{S+p_1}$$



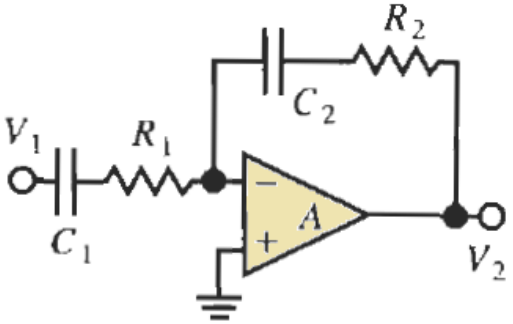
Different toplogies single Equation Solution

$$|T(S)| = -\frac{Z_2}{Z_1} = -K\frac{S+z_1}{S+p_1}$$

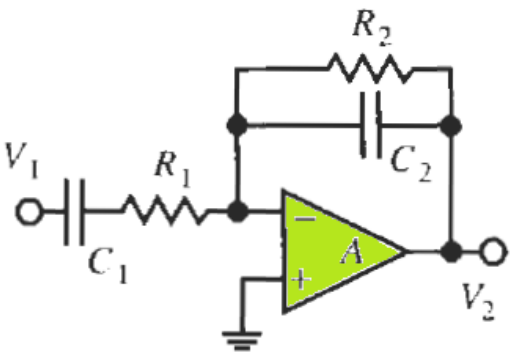




$$|T(S)| = \frac{R_2}{R_1}\frac{Sc_1R_1+1}{Sc_2R_2+1}$$

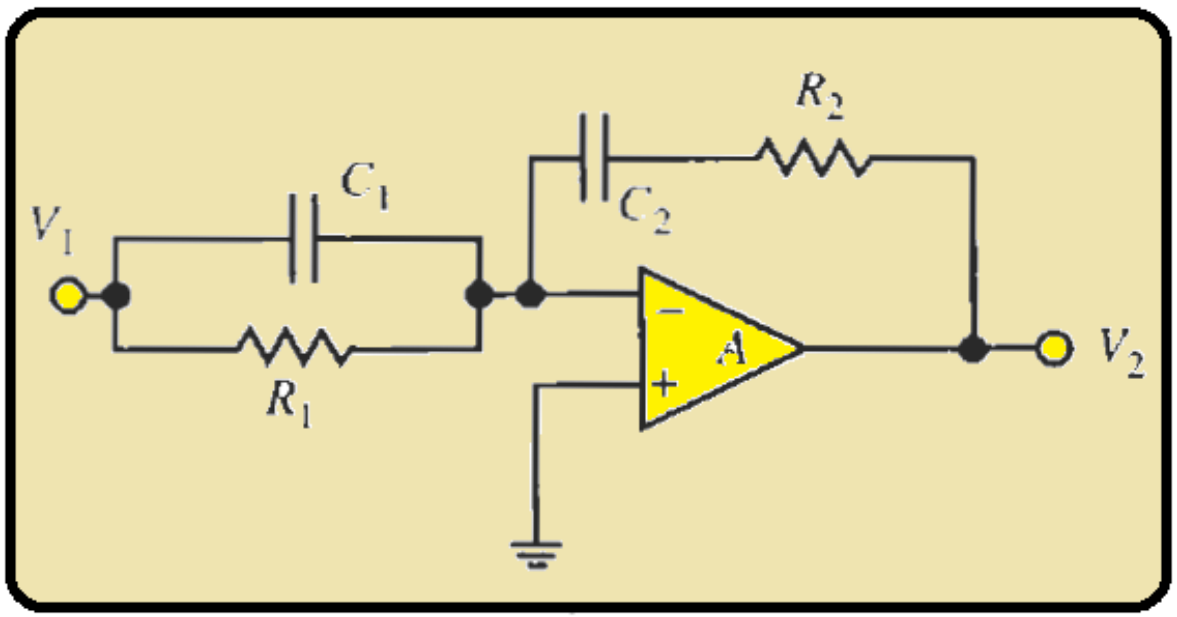


$$|T(S)| = \frac{c_1}{c_2}\frac{Sc_2R_2+1}{Sc_1R_1+1}$$



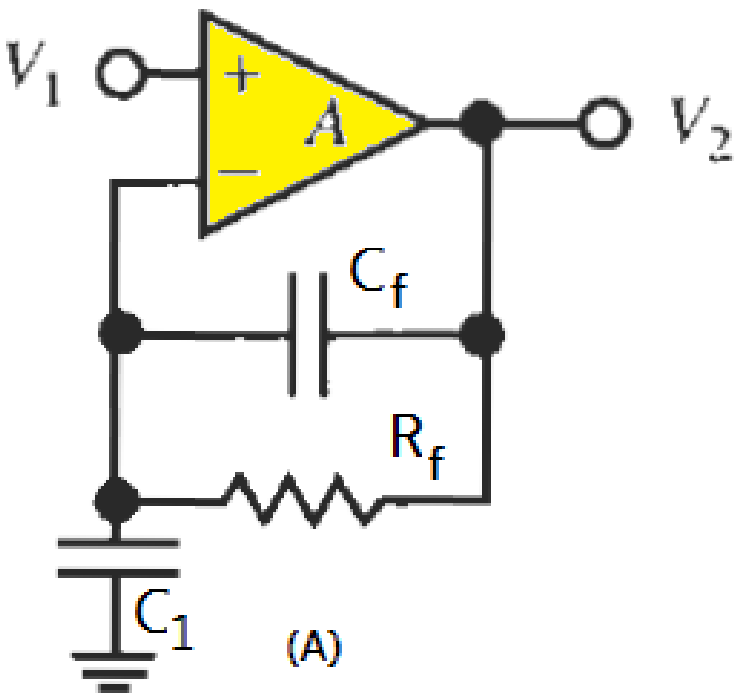
$$|T(S)| = \frac{Sc_1R_2}{(Sc_1R_1+1)(Sc_2R_2+1)}$$

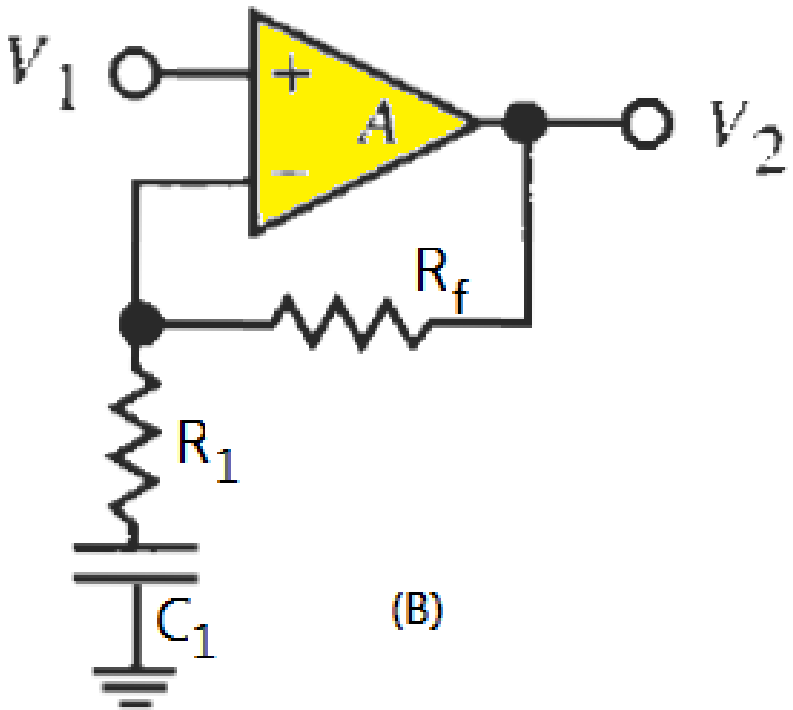
Not all topologies are valid



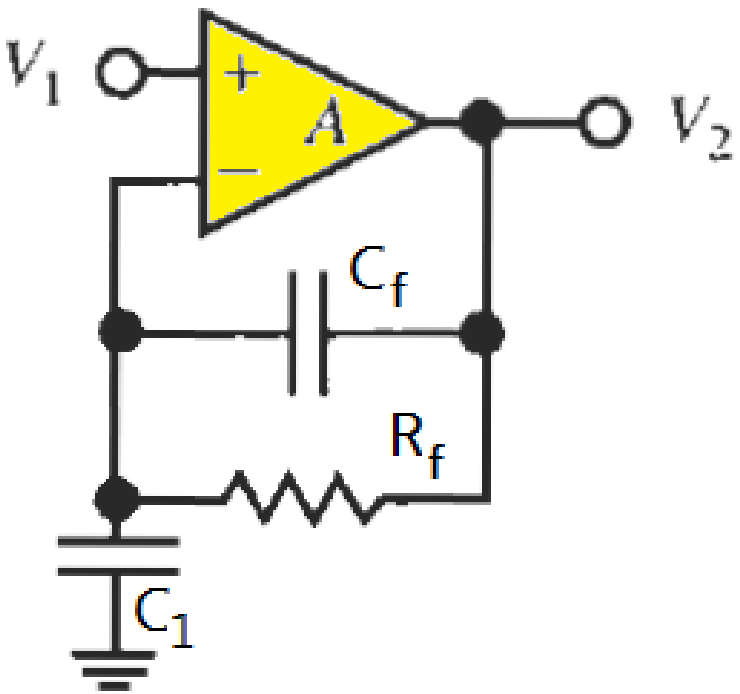
- $\omega = 0 \Rightarrow Z_c = \infty \Rightarrow$ open loop circuit.
- $\omega = \infty \Rightarrow Z_c = 0 \Rightarrow$ gain $= \infty$

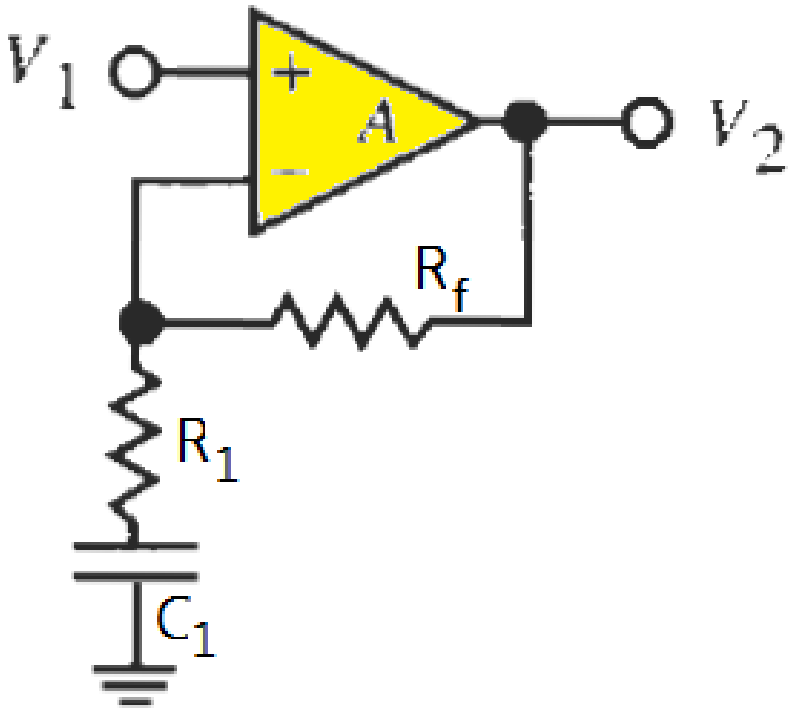
Low pass Filter





Low pass Filter





$$\frac{1 + SR_f(C_f + C_1)}{1 + SC_fR_f}$$

(A)

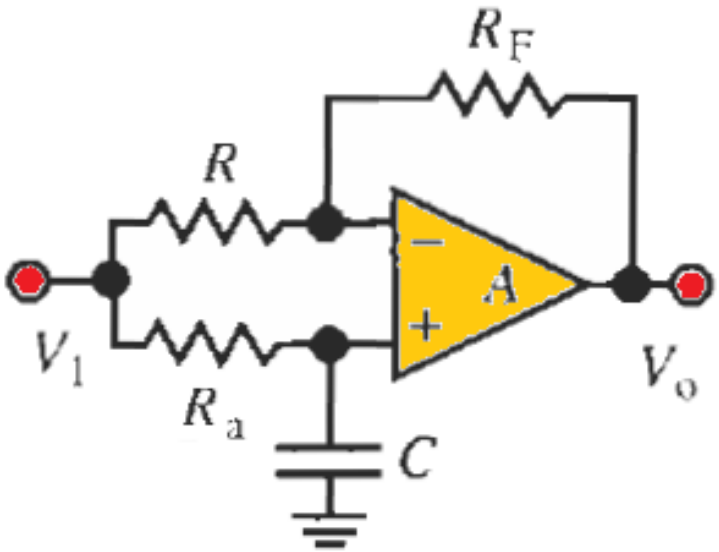
$$\frac{1 + SC_1(R_f + R_1)}{1 + SC_1R_f}$$

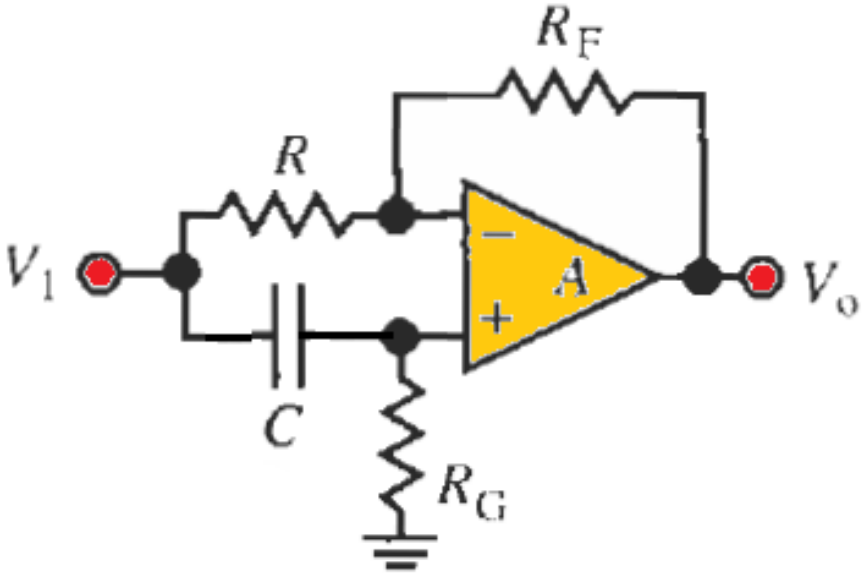
(B)

Inverting vs. Non-inverting Op Amp

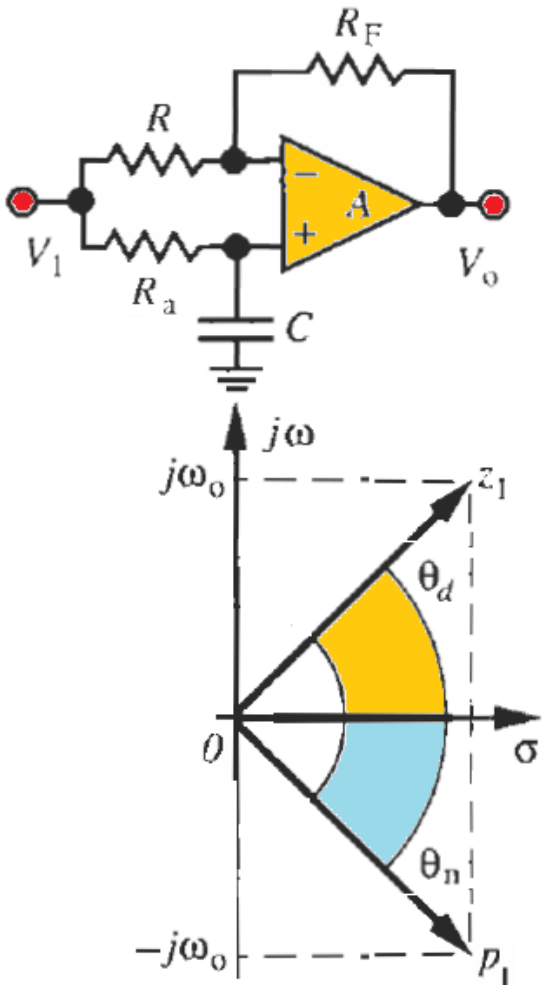
	Inverting op Amp	Non-inverting
Gain	Attenuation/Amplification	buffer / amplification
Component	4 passive elements	3 passive elements
Implementation Technology	-	adaptable (use resistors or capa
Input Impedance	matching	∞

Allpass Filter





Allpass Filter



Let: $R = R_F$

$$V^+ = V_1 \frac{\frac{1}{SC}}{R_a + \frac{1}{SC}} = V_1 \frac{1}{1 + SCR_a}$$

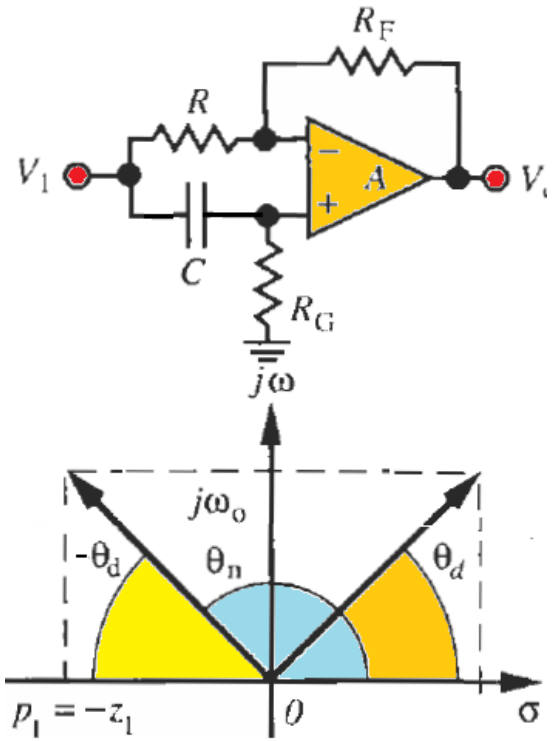
$$T(S) = V^+(1 + \frac{R_f}{R}) - V^- \frac{R_f}{R}$$

$$T(S) = \frac{2}{1 + SCR_a} - 1 = \frac{1 - SCR_a}{1 + SCR_a}$$

$$|T(S)| = 1$$

$$\angle T(S) = \tan^{-1} \frac{-\omega}{1} - \tan^{-1} \frac{\omega}{1} = -2 \tan^{-1} \omega CR_a$$

Differential OpAmp , Allpass Filter



Let: $R = R_F$

$$V^+ = V_1 \frac{R_a}{R_a + \frac{1}{SC}} = V_1 \frac{SCR_a}{1 + SCR_a}$$

$$T(S) = V^+(1 + \frac{R_f}{R}) - V^- \frac{R_f}{R}$$

$$T(S) = \frac{2SCR_a}{1 + SCR_a} - 1 = \frac{SCR_a - 1}{SCR_a + 1}$$

$$|T(S)| = 1$$

$$\angle T(S) = \tan^{-1} \frac{\omega}{-1} - \tan^{-1} \frac{\omega}{1}$$

$$= 180 - 2\tan^{-1} \omega CR_a$$