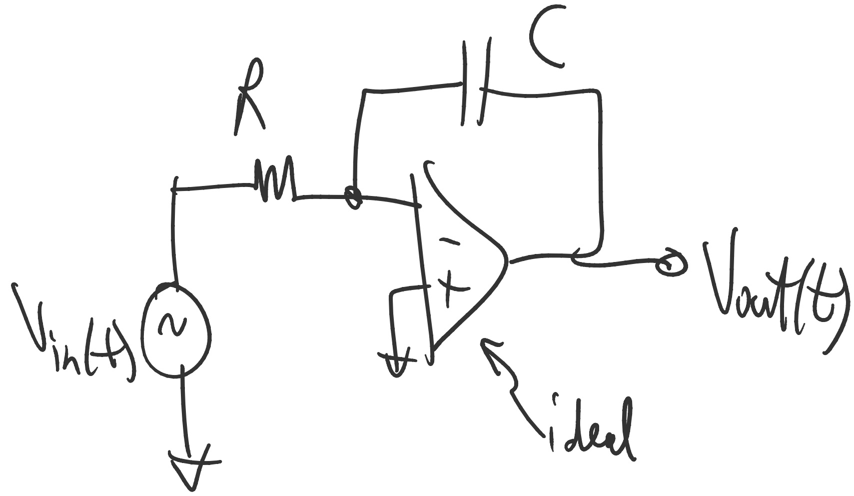
Friday, October 26, 2018 9:59 AM

Example

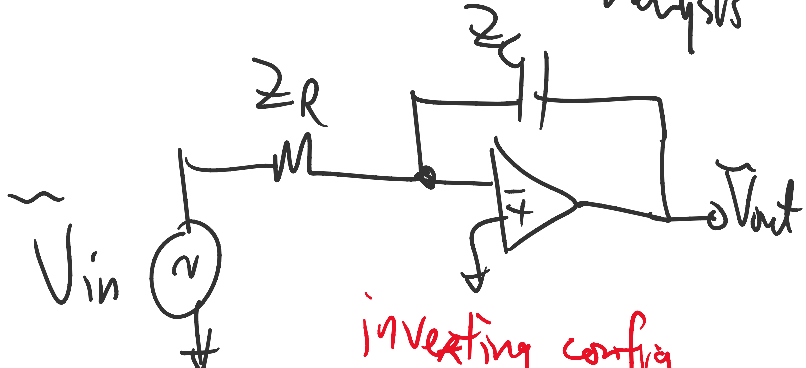


$V_{in}(t) = \cos(\omega_0 t)$

$= \cos(2\pi f_0 t)$, $f_0 = 5\,kHz$

$R = 100\Omega$, $C = 1\mu F$ ⟹ Determine $V_{out}(t)$ via phasor analysis

phasor domain ckt



inverting config.

$\tilde{V}_{in} = 1\angle 0^\circ V$

$Z_R = 100\Omega\ (= R)$, $Z_C = \frac{-j}{\omega_0 C} = \frac{-j}{2\pi(5k)(1\mu)} \cong -j31.83\Omega$

$$A_V = \frac{\tilde{V}_{out}}{\tilde{V}_{in}} = \frac{-Z_C}{Z_R} = -\left(\frac{-j31.83}{100}\right) = \frac{31.83\angle 90^\circ}{100\angle 0^\circ}$$

$$= 318.31m\angle +90^\circ\ V/V$$

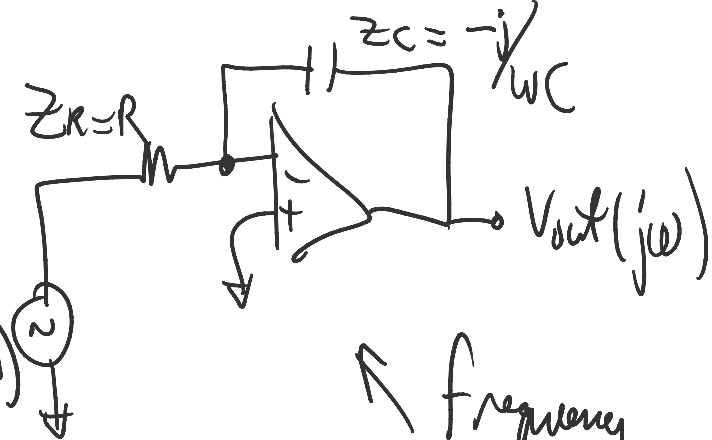
$$\tilde{V}_{out} = (A_V)(\tilde{V}_{in}) = (318.31m\angle 90^\circ)(1\angle 0^\circ)$$

$$(V/\cancel{V}) \quad (\cancel{V})$$

$$= 318.31m\angle 90^\circ \ V$$

$$V_{out}(t) = P^{-1}\{\tilde{V}_{out}\} = 318.31\cos(\omega_0 t + 90^\circ)\ mV$$

How will this ckt behave over a range of frequencies?



↖ frequency domain ckt

$$A_V(j\omega) = \frac{V_{out}(j\omega)}{V_{in}(j\omega)}$$

$$= \frac{-Z_C}{Z_R} = \frac{-(-j/\omega C)}{R} = \frac{+j}{\underbrace{\omega RC}_{V/V}} = \frac{1}{\omega RC}\angle +90^\circ \quad V/V$$

$$|A_V| = \frac{1}{\underbrace{\omega RC}_{V/V}}, \quad \angle A_V = +90^\circ$$

$\omega \uparrow$

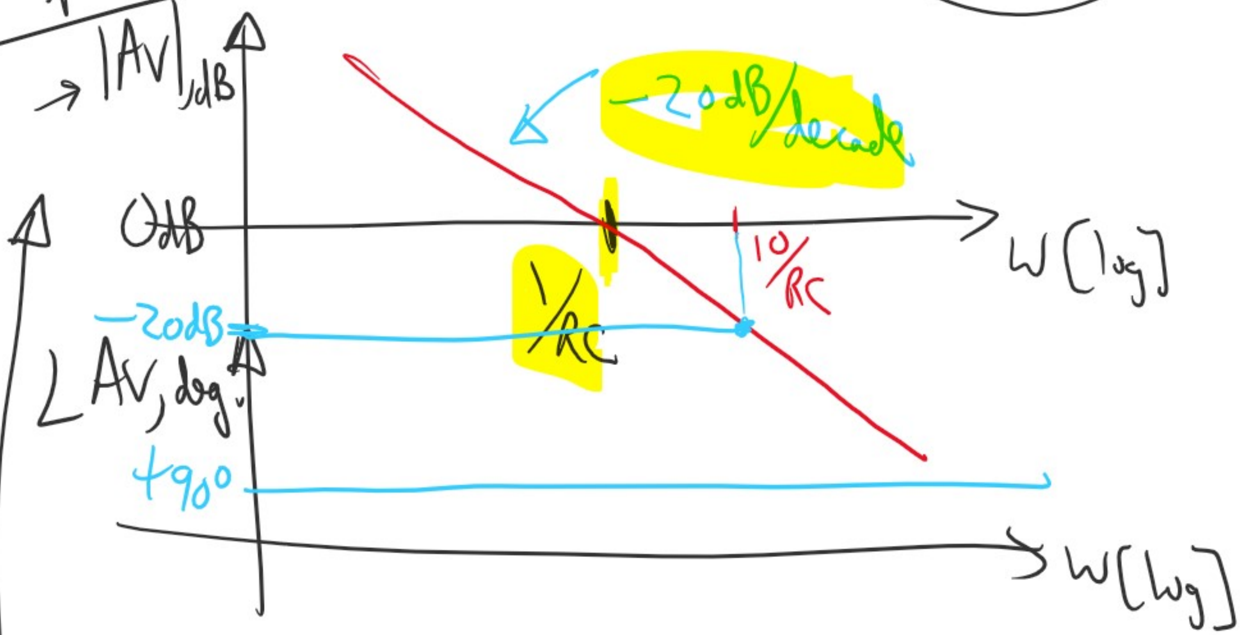
$|A_V|$

V/V

$|A_v| \downarrow$

Bode response

dB
decibel



$20\log_{10}(|A_v|)$

$\frac{1}{\omega RC} \overset{set}{=} 1\,V/V \Rightarrow \omega = \frac{1}{RC}$

$|A_v| = \frac{1}{\omega RC}$