

How do you determine V_o at a frequency one octave above the critical frequency if $R=1\text{ k ohm}$ and $C=0.01\text{ micro Farads}$ in series $V_{in}=10\text{mV}$

Solution

It's first order low-pass RC filter.

First find the cutoff frequency,

$$f_c = \frac{1}{2 * \pi * R * C} = \frac{1}{2 * \pi * 10^3 \text{ohm} * 0.01 * 10^{-6} F} = 15923 \text{ hertz}$$

One octave above, $f = 31846 \text{ hertz}$.

The capacitive reactance of a capacitor in an AC circuit is given as

$$X_C = \frac{1}{2 * \pi * f * C} = \frac{1}{2 * \pi * 31846 \text{ hertz} * 0.01 * 10^{-6} F} = 500 \text{ ohm.}$$

The output voltage V_{out} :

$$V_{out} = V_{in} * \frac{X_C}{\sqrt{(R)^2 + (X_C)^2}} = 10 * 10^{-3} V \frac{500}{\sqrt{1000^2 + 500^2}} = 0.447 * 10^{-2} V = 4.47 \text{mV.}$$

Answer: 4.47mV.