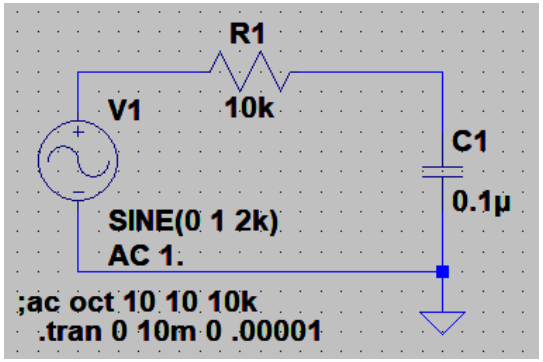
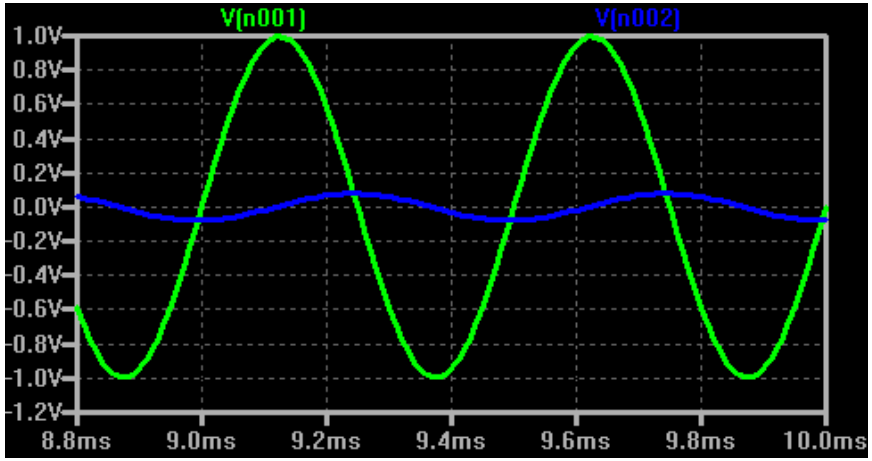
RC Circuit AC analysis

Via LTspice simulation



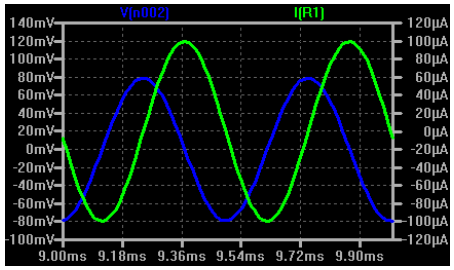


Simulated RC at 2 kHz

V1 and Vc plotted

Analysis:

Vc and Ir = Ic compared



V1 = 1 at 0°, V_C = 78.9 mv at -85.3*

$$T1 = 9.6185ms, T2 = 9.5\ ms\ so\ DeltaT = 0.1185\ msec, but\ T = 0.5\ ms$$

$$\frac{0.1185}{0.5} = 0.237\ of\ a\ full\ period, 0.237 * 360 = -85.3°$$

Note: the minus sign is due to the fact that the capacitor voltage is delayed WRT the input.

The voltage across the 10k resistor is the difference between V1 and Vc

$$V_C = 78.9\ mv * [cos(85.3) + jsin(-85.3)]$$

$$V_C = 78.9\ mv * [0.0816 - j0.9967], V_R = 1 - 0.0064 + j0.0786$$

Now we can subtract Vc from V1 $:V_R = 0.9935 + j0.0786\ or\ V_R{\sim}1\ at\ arctan(0.791), or\ V_R{\sim}1\ at\ 4.5°$

Therefore $I_R = I_C = V_R/10k$ = 0.1 mA at 4.5° Note that the angle between V_C and I_C = -85.3 - 4.5 = -89.8 ~ -90° **with only ~0.2% error**

$\frac{Vc}{Ic} = Z_C = \frac{1}{j\omega C} = -\frac{-j}{(2\pi * 2 * 10^3 * 0.1 * 10^{-6})}\ or\ Z_C = -795j$ Compare to $\frac{Vc}{Ic} = \frac{78.9 * 10^{-3}}{10^{-4}} = -789j$ and is **within 1% error**