Week 1 Lab

Lillian Tucker

Sunday, January 29, 2023 10:53 AM

1. Assume that you want to use a 10 kHz sinusoidal signal in the lab that has no DC component and swings from -1.0 V to +1.0 V. Fill in the blanks to refer to the 3 different ways you might refer to this signal. Show your work on the side for full credit. Assume no phase shift.

2 $V_{peak-to-peak}$ or Vpp $\quad Vpp = 2 \cdot Vpk = 2 \cdot 1$

1 V_{peak} or Vpk

0.707 V_{Rms} $\quad Vrms = \frac{1}{\sqrt{2}} \cdot Vpk = \frac{1}{\sqrt{2}} \cdot 1$

2. How do the conversion formulas for V_{RMS} differ for Vpk and Vpp? Write them below.

$Vrms = \frac{1}{\sqrt{2}} \cdot Vpk$

$Vrms = \frac{1}{2\sqrt{2}} \cdot Vpp$

$Vpk = \frac{1}{2} \cdot Vpp$

$Vpp = 2 \cdot Vpk$

(Figure 1: Question 1 & 2 solved)

3. Design a voltage divider using resistors and capacitors. Assume that Vin is your reference signal (show this on channel 1) and Vo is desired output signal (show this on channel 2). For this circuit assume that $\omega =$ 10000 rad/s or 10 krad/s. A summary of design constraints:
   - Resistors must be greater than 200 Ω
   - $|Vo| = 0.707\ Vin = \frac{\sqrt{2}}{2} Vin$
   - The phase of Vo must lead Vin by 45°

   Draw and label your final design in the box. Also, state the frequency of Vin in Hz. Build and test this design.

   Hint: what happens when $|Xc| = R$ in a voltage divider circuit?

(Figure 2: Question 3)

$V_{in} = 4\,V_{pp} = 2\,V_p$

$V_o = \frac{\sqrt{2}}{2} \cdot V_{in} = 2.82842\,V_{pp} = 1.41421\,V_p$

$V_o = V_{in}\left(\frac{Z_2}{Z_1+Z_2}\right)$

$1.414\angle 45° = 2\left(\frac{Z_2}{Z_1+Z_2}\right)$

$0.5 + j0.5 = \frac{Z_2}{Z_1+Z_2}$

$Z_1 = (0.5+j0.5) = Z_2(0.5+j0.5)$

$Z_1 = Z_2$ ∴ for a 45° phase shift, $R = C$

$R = 1000 \quad \omega = 10{,}000\ \frac{rad}{s}$

$X_C = \frac{1}{j\omega C} \rightarrow -j1000 = \frac{1}{j(10{,}000)C}$ → $C = 0.1\,\mu F$

$\omega = \frac{10{,}000}{2\pi} = 1591.55\ Hz$

CH1: $V_{in} = 4\,V_{pp}$

CH2: $V_o = 2.8\,V_{pp}$

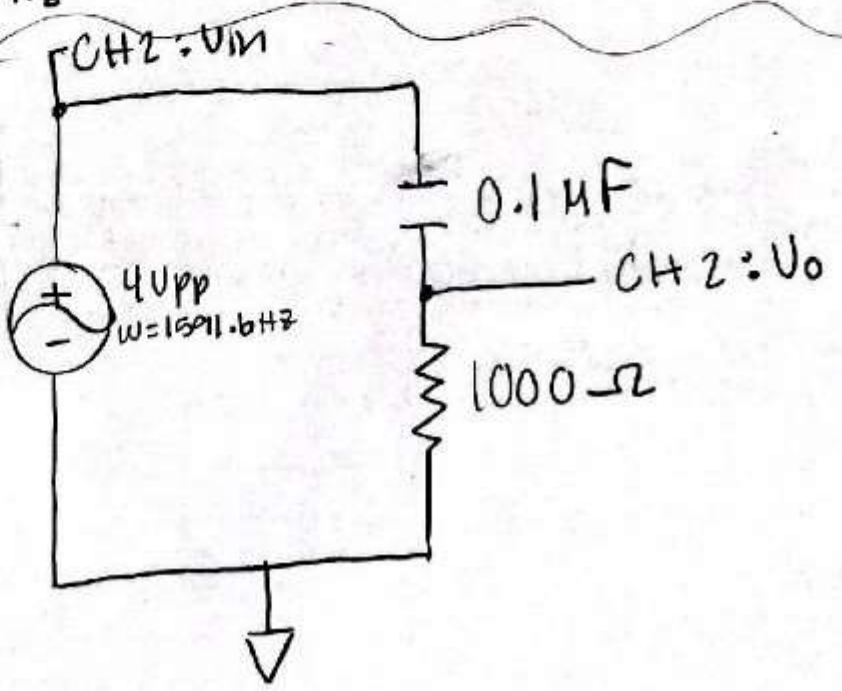
$\omega = 1591.55\ Hz$

$R = 1000\,\Omega$

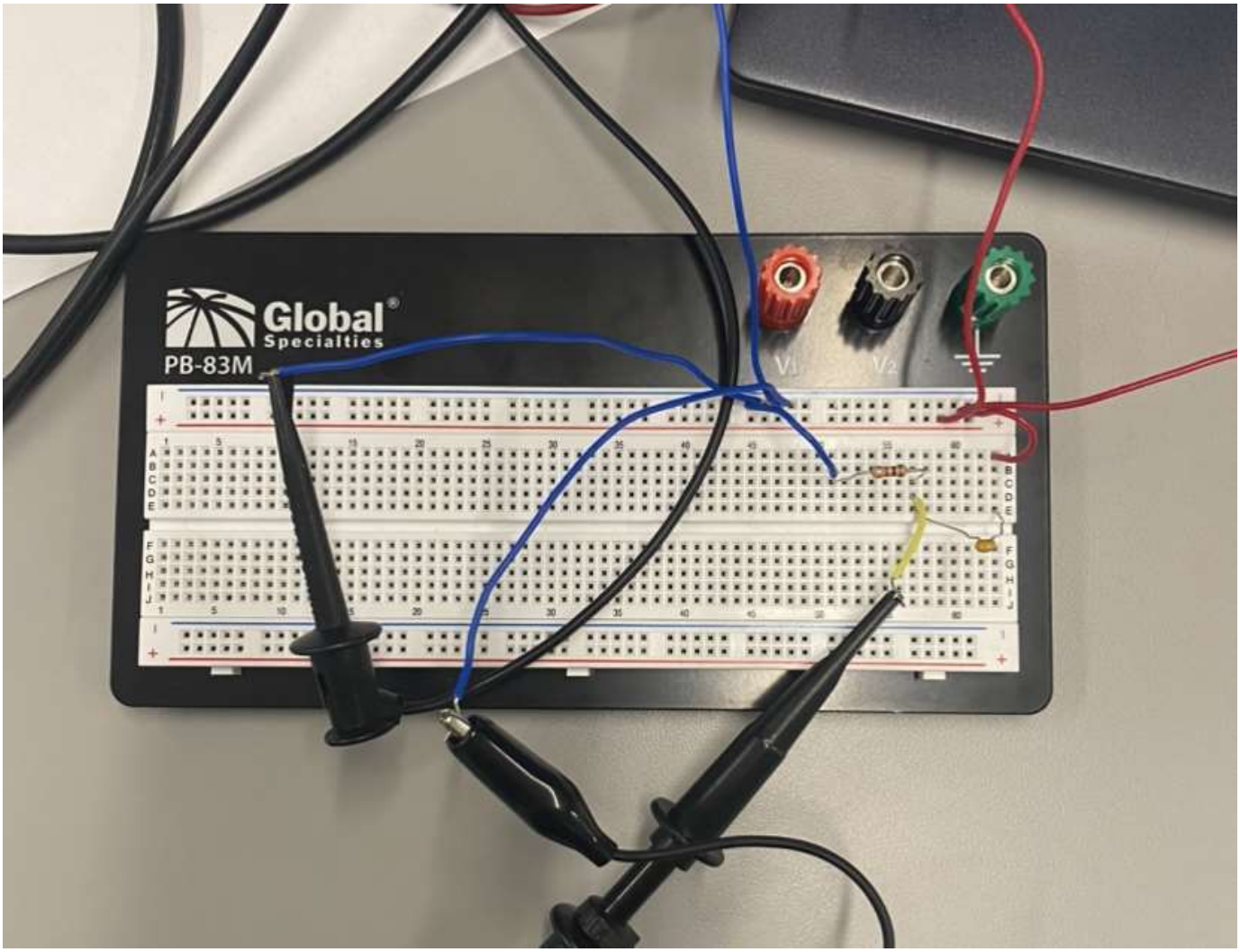
$C = 0.1\,\mu F$

→ Vin leads

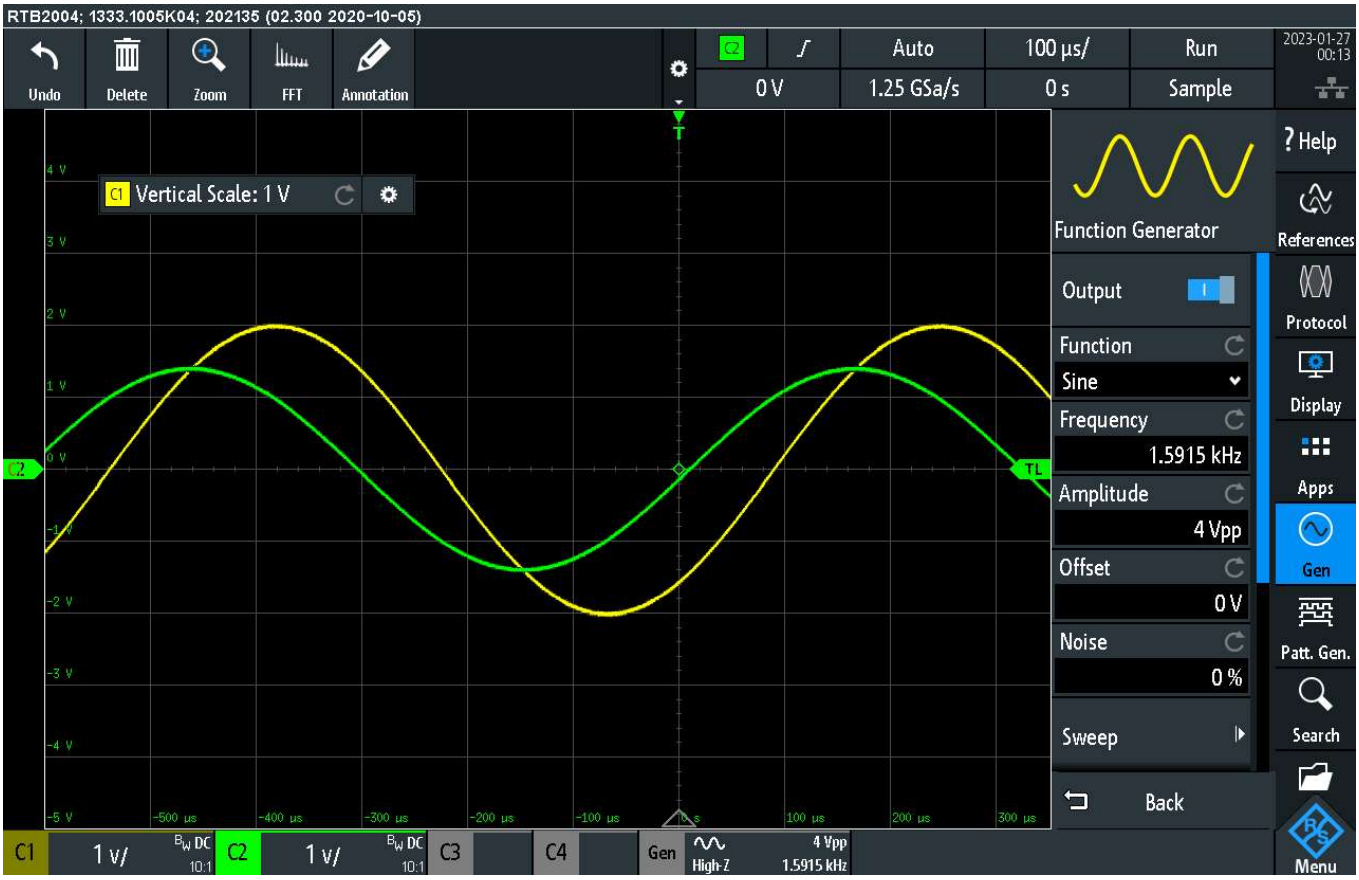
→ Vo leads



(Figure 3: Circuit Calculations and Design w Measurements)



(Figure 4: Circuit Set Up)



(Figure 5: Oscilloscope w Measurements and Function Generator)