Circuits II

"How to Have Fun on the Weekends"

1. Write the expressions for the following waveforms:
   a. 2 volt peak-sine wave at 2 kHz
   b. 10 volt rms sine wave at 1 kHz
   c. 15 volt peak-peak sine wave at 1 kHz, lagging by 90°
   d. 5 volt peak sine wave at 100 kHz riding on a +2 V DC offset.

2. Plot waveform 1-A as seen on an oscilloscope with the following settings (assume ground is centered and the trigger level and slope are set to start the trace as the waveform passes through 0, going positive).
   a. Vertical: 1 V/div, Horizontal: 100 μsec/div, Coupling: AC

3. Plot waveform 1-B as seen on an oscilloscope with the following settings (assume ground is centered, trigger slope is negative, trigger level is approx +1V).

4. Find \( X_L \) if \( f = 1 \text{ kHz}, L = 1 \text{ mH} \)

5. Find \( X_C \) if \( f = 100 \text{ kHz}, C = 1 \mu \text{F} \)

6. Find \( Z \) for a series combo of \( R = 1 \text{ kΩ}, L = 10 \text{ mH} \), if \( f = 20 \text{ kHz} \)
7. Draw the 3 voltage waveforms for the circuit below. \((v_{in}, v_r, v_c)\). Also, determine total power dissipated.

![Circuit Diagram](Image)

\(V_{in} = 5\, \text{V peak at 1kHz}\)

8. Draw the 4 voltage waveforms for the circuit below. \((v_{in}, v_r, v_c, v_i)\)

![Circuit Diagram](Image)

\(V_{in} = 1\, \text{Volt at 500kHz}\)

9. Find the frequency for the circuit of problem 8 such that \(X_L = X_C\), and determine \(Z\) of the circuit at that point.
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1. (A) \[ v(t) = 2 \sin 2\pi 1000t \]
   (B) 10V RMS = 14.14V Peak, \[ v(t) = 14.14 \sin 2\pi 1000t \]
   (C) 14V p-p = 5V p-p, \[ v(t) = 5 \sin(2\pi 1000t - 90^\circ) \]
   (D) \[ v(t) = 5 \sin(2\pi 1000t + 2) \] (note lack of parentheses for \( \sin \))
      or \[ v(t) = 2 + 5 \sin(2\pi 1000t) \] (less confusing)

2. (a) - see graphs

3. \[ X_L = \frac{2\pi f L}{1} = 2\pi 1\text{kHz} \cdot 1\text{mH} = 6.28 \text{\Omega} \]

4. \[ X_C = \frac{1}{2\pi f C} = \frac{1}{2\pi 100\text{kHz} \cdot 1\mu F} = 15.9 \text{\kilo\Omega} \]

5. \[ X_L = \frac{2\pi f L}{1} = 2\pi 2\text{kHz} \cdot 1\text{mH} = 12.56 \text{\Omega} \]

\[ Z = 1k + j \cdot 1256 \text{ \Omega} = 1600.5 \angle 51.5^\circ\ \text{\Omega} \]

6. \[ X_L = \frac{2\pi f L}{0.5 \mu F} = 31.8 \text{\kilo\Omega} \]

\[ Z = 1000 - j \cdot 318 \text{ \Omega} = 333.3 \angle -72.6^\circ \text{ \Omega} \]

\[ i = \frac{5.25^\circ \cdot 5}{333.3 \angle -72.6^\circ} \text{ \Omega} = 15 \angle 72.6^\circ \text{ mA} \]

\[ V_C = 100 \angle 15^\circ \cdot 72.6^\circ \text{mA} = 1.5 \angle 72.6^\circ \text{V} \]

\[ P = \frac{(1.5 \text{\ mA})^2}{2} \cos 72.6^\circ = 1.12 \text{\ mW} \]

\[ V_C = 318 \angle -90^\circ \text{V} \]

\[ V_C = 15 \angle 72.6^\circ \text{mV} \]

\[ V_C = 4.77 \angle -17.4^\circ \text{V} \]
Fun so much weekend fun - Circuits #5

**2A** Period = \( \frac{1}{2 \, \text{kHz}} = 500 \, \mu\text{sec} \)

Expanded to 1 cycle

**2B** At 2V/DIV we can only see 4 cycles

The top and bottom are chopped off

At 2V/DIV, we can see 4 cycles

DC coupling lets us see both AC + DC (No DC anyway)

**3A** AC coupling Removes DC (No DC present anyway)

**3B** AC coupling Removes DC Offset

Using same trigger as 2A + 2B

**3A** We can see a total of 2V/SEC = 2 cycles

DC coupling shows everything

2V/SEC

DC coupling shows everything

2V/SEC
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so much fun on the weekends fun (answers, cont.)

\[ X_C = \frac{1}{2\pi fC} = \frac{1}{2\pi \times 500 \times 1\mu F} = \frac{1}{3185}\text{\ O}\ 
X_L = 2\pi fL = 2\pi \times 500 \times 400\text{\ mH} = 12.56\text{\ O}\ 

Z = 1K + j1256 = 3185\text{\ O} = 1K - j1929\text{\ O} = 2173\angle 62.6^\circ\text{\ O}\ 

C = \frac{160^\circ}{2173\angle 62.6^\circ}\text{\ O} = 0.46\text{\ mA}\text{\ L}62.6^\circ\text{\ O} \text{ (current leads voltage - circuit is basically capacitive)}.

\[ V_C = 1K \times 0.46\text{\ mA}\angle 62.6^\circ = 0.46\text{\ V}\angle 62.6^\circ\ 
V_L = 3185\angle 0^\circ \times 0.46\text{\ mA}\angle 62.6^\circ = 1.47\angle 29.4^\circ\text{\ V}\ 
\]

NOTE THAT \( V_L \) and \( V_C \) are 180° out of phase.

\( V_L \) leads \( V_R \) by 90°; \( V_C \) lags \( V_R \) by 90°.

\( \theta \) since \( X_L = 2\pi fL \) and \( X_C = \frac{1}{2\pi fC} \), if \( X_C = X_L \) then

\[ \theta = \frac{1}{2\pi fC} \quad \theta = \frac{1}{2\pi fL} \quad \therefore \frac{1}{\theta} = \frac{2\pi fL}{2\pi fC} \quad \therefore \frac{1}{\theta} = \frac{2\pi fL}{2\pi fC} \]

\[ S = \frac{1}{2\pi fLC} \quad \therefore S = \frac{1}{2\pi f\times 1\mu F \times 400\text{\ mH} = 796\text{\ Hz}} \]

\[ X_L = \theta = \frac{796 \times 400\text{\ mH} = 2K\text{\ O}} \quad X_C = \frac{1}{2\pi \times 796\text{\ mF} = 2K\text{\ O}} \ 
Z = 1K\text{\ O} + j2K - j2K = 1K\text{\ O} \]