203-NYB-05
Electricity and Magnetism
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AC Circuits: Lab 1

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Procedure

Apparatus

Results

a) AC circuit with a single resistor

Measurements

$$\Delta \mathrm{V}_{\max} = 4.0\mathrm{V} \pm 0.2\mathrm{V} \tag{1}$$
$$\Delta \mathrm{V}_{rms} = 2.79\mathrm{V} \pm 0.06\mathrm{V} \tag{2}$$
$$I_{rms} = 4.0\mathrm{V} \pm 0.2\mathrm{V} \tag{3}$$
$$T = 1.00\mathrm{ms} \pm 0.04\mathrm{ms} \tag{4}$$

Calculations

$$\begin{aligned}
\Delta \mathrm{V}_{rms} &= \frac{\Delta \mathrm{V}_{\max}}{\sqrt{2}} \\
\Delta \mathrm{V}_{rms} &= \frac{4.0\mathrm{V} \pm 0.2\mathrm{V}}{\sqrt{2}} \\
\Delta \mathrm{V}_{rms} &= 2.8\mathrm{V} \pm 0.1\mathrm{V}
\end{aligned} \tag{5}$$

$$\begin{aligned}
P_{avg} &= \Delta \mathrm{V}_{rms} I_{rms} \\
P_{avg} &= 2.79\mathrm{V} \pm 0.06\mathrm{V} * 4.0\mathrm{V} \pm 0.2\mathrm{V} \\
P_{avg} &= 0.285\mathrm{W} \pm 0.012\mathrm{W}
\end{aligned} \tag{6}$$

$$\begin{aligned}
F &= \frac{1}{T} \\
F &= \frac{1}{0.001\mathrm{s} \pm 0.0004\mathrm{s}} \\
F &= 1000\mathrm{Hz} \pm 40\mathrm{Hz}
\end{aligned} \tag{7}$$

Discussion

The voltage$_{rms}$ measured at (**??**) agrees with the calculated value at (**??**)
The frequency calculated at (**??**) agrees with the given value of 1000 Hz
When the frequency was set to 100Hz, a time scale of 2ms/div was needed for proper observation
When the frequency was set to 10Hz, a time scale of 20ms/div was needed for proper observation. The sine wave shown on the oscilloscope also started flashing
Since this is an ac circuit, the lamp should flash twice per period. Thus, by setting the frequency to 1 Hz should make the lamp light up 20 times over 10 seconds. This was confirmed when tested, and the lamp does flash twice per period because there is two voltage peaks during one period.

b) AC circuit with an inductor

Measurements
With F=1800Mhz

$$\Delta \mathrm{V}_{Lrms} = 2.73\mathrm{V} \pm 0.06\mathrm{V} \tag{8}$$
$$I_{rms} = 23.8\mathrm{mA} \pm 0.8\mathrm{mA} \tag{9}$$

With F=1600Mhz

$$\Delta \mathrm{V}_{Lrms} = 2.73\mathrm{V} \pm 0.06\mathrm{V} \tag{10}$$
$$I_{rms} = 26.4\mathrm{mA} \pm 0.8\mathrm{mA} \tag{11}$$

Calculations

$$\begin{aligned} \Delta \mathrm{V}_{Lrms} &= X_L I_{rms} \\ X_L &= \frac{\Delta \mathrm{V}_{Lrms}}{I_{rms}} \\ X_L &= \frac{2.73\mathrm{V} \pm 0.06\mathrm{V}}{23.8\mathrm{mA} \pm 0.8\mathrm{mA}} \\ X_L &= 11.47\frac{\mathrm{V}}{\mathrm{A}} \pm 0.29\frac{\mathrm{V}}{\mathrm{A}} \end{aligned} \tag{12}$$

$$\begin{aligned} X_L &= \omega L \\ L &= \frac{X_L}{\omega} \\ L &= \frac{114.7\frac{\mathrm{V}}{\mathrm{A}} \pm 0.3\frac{\mathrm{V}}{\mathrm{A}}}{2\pi 1800\mathrm{Hz}} \\ L &= 10.14\mathrm{mH} \pm 0.26\mathrm{mH} \end{aligned} \tag{13}$$

Discussion
The value of L calulated at (**??**) agrees with the nomival value of $10\mathrm{mH} \pm 1\mathrm{mH}$ When the frequency of the ac source was changed to 1600hz the $\Delta \mathrm{V}_{Lrms}$ did not change and the I_{rms} went down linearly.

c) AC Circuit with a capacitor

Measurements

$$\Delta \mathrm{V}_{Crms} = 2.76\mathrm{V} \tag{14}$$
$$I_{Crms} = 16.8\mathrm{mA} \tag{15}$$

Calculations

$$\begin{aligned}
\Delta \mathrm{V}_{Crms} &= X_L I_{Crms} \\
X_C &= \frac{\Delta \mathrm{V}_{Crms}}{I_{Crms}} \\
X_C &= \frac{2.76\mathrm{V}}{16.8\mathrm{mA}} \\
X_C &= 164.3\frac{\mathrm{V}}{\mathrm{A}}
\end{aligned} \tag{16}$$

$$\begin{aligned}
X_C &= \frac{1}{\omega C} \\
C &= \frac{1}{\omega X_C} \\
C &= \frac{1}{2\pi 1000\mathrm{Hz} * 164.3\frac{\mathrm{V}}{\mathrm{A}}} \\
C &= 0.9687\mathrm{\mu F}
\end{aligned} \tag{17}$$

$$\begin{aligned}
\%error &= 100 * (C_{cal} - 1.00\mathrm{\mu F})/1.00\mathrm{\mu F} \\
\%error &= 100 * (0.9687\mathrm{\mu} - 1.00\mathrm{\mu F})/1.00\mathrm{\mu F} \\
\%error &= 3.13\%
\end{aligned} \tag{18}$$