lab 11.4.1 Week 12

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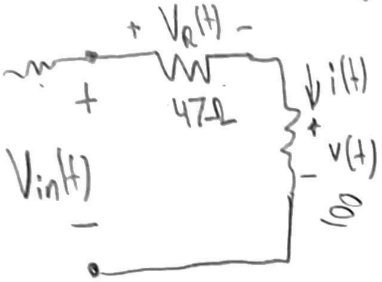
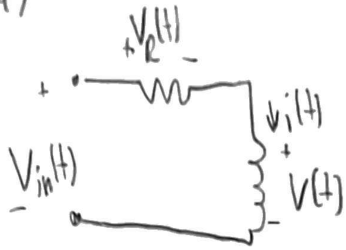
Assume $V_R(t) = V_R\cos(\omega t + \theta)$

form $v(t) = V\cos(\omega t + \phi)$

$$Z = \frac{\mathbb{V}}{\mathbb{I}} = \frac{V_m e^{j\phi}}{I_m e^{j\theta}} = \frac{V_m}{I_m} e^{j(\phi-\theta)}$$





$$\mathbb{I} = \frac{V_{in}}{Z}$$

$$V_{in}\angle 0^\circ = V_R\angle\theta + V\angle\phi$$

$$V\angle\phi = V_{in}\angle 0^\circ - V_R\angle\theta$$

0 for resistor

$$V\angle\phi = V_{in}e^{j0} - V_R e^{j\theta} = \boxed{V_{in} - V_R e^{j\theta}}$$

$$i_R\angle\theta = \frac{V_R\angle\theta}{R} \rightarrow \frac{V_{in}}{Z} = \frac{V_R\angle\theta}{R} \quad Z = \frac{RV_{in}}{V_R\angle\theta}$$

$$Z = \frac{V_{in} - V_R\angle\theta}{\left(\frac{V_R\angle\theta}{R}\right)} = R\left(\frac{V_{in}}{V_R\angle\theta} - 1\right)$$

$$= R\left(\frac{V_{in}e^{j0}}{V_R e^{j\theta}} - 1\right)$$

$$Z = R\left(\frac{V_{in}}{V_R e^{j\theta}} - 1\right)$$

we don't know

We figure out $V_R e^{j\theta}$ from

$$V_R\angle\theta = V_{in} - V\angle\phi$$

$$V(t) = 4 \times \left(\frac{100}{100+47}\right) = 2.72\text{ V}$$

$$4 \times \left(\frac{100}{100+1k}\right) = 396\text{ mV}$$

(a) Changed to 1K

ω	$V(t)$ P2P
1 kHz	380 mV
5 kHz	380 mV
10 kHz	380 mV

t diff = 0

$$Z = \frac{380\text{ mV}}{\left(\frac{380\text{ mV}}{100}\right)} = 100\,\Omega$$

Changed to (b) 10.14 mH

ω	$V_R(t)$ P2P
1 kHz	3.66 V
5 kHz	3.18 V
10 kHz	2.39 V

$$I_m = \frac{V_{Rm}}{470\,\Omega}$$

for all f

$$V_c = V_{in} - V_R\angle\theta$$

$$\text{Phase} = \frac{\Delta T}{T} \times 360^\circ$$

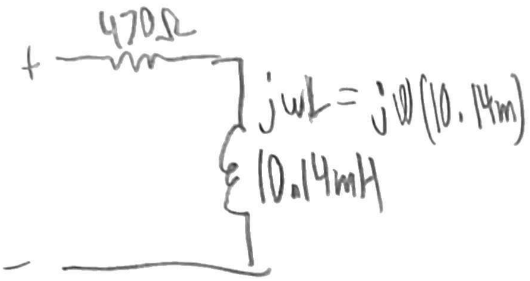
$$= \frac{220\,\mu s - 240\,\mu s}{1\text{ ms}} \times 360^\circ = -0.001^\circ$$

phase diff

1 kHz

$$Z = 470\left(\frac{4\text{ V}}{\sim 3.66\text{ V}} - 1\right) \approx 43.7\,\Omega$$

Theoretical vals



ω	Z
1k	10.14j
5k	50.7j
10k	101.4j

$Z = 470 + 10.14j$

$V = 2\angle 0^\circ$

$I = \dfrac{2\angle 0^\circ}{470 + 10.14j}$

$I = 4.25 \angle -1.24^\circ$ mA

$V_{in} = V_R \angle\theta + V_L \angle\phi$

$V_L \angle\phi = V_{in} - V_R \angle\theta = 2 - 1.83V$

$= 0.17$

$\dfrac{V_L \angle\phi}{I \angle\theta} = Z$

$\dfrac{V_L \angle\phi}{4.25 \angle -1.24^\circ} = 470 + 10.14j$

$V_L \angle\phi = 1.998 \angle -7.096^\circ$

$V_L \approx 2\cos(1000t - 7.096^\circ)$

measured

ω	V_L
1k	$.2\cos(1000t - 7.096^\circ)$
5k	$.2\cos(5{,}000t + 37.2^\circ)$
~~10k~~	

5k:

$\dfrac{20\mu s}{200\mu s} \times 360^\circ = 36^\circ$ measured phase diff

V_R leading $20\mu s$

$V_R = \dfrac{3.18}{2}\cos(5kt + 36^\circ)$

$1.59 \angle 36^\circ$

$V_L \approx 2\angle 37.2^\circ$

Percent error

$$\boxed{\frac{0.2 - 0.19}{0.19} \times 100 = 5.26\%}$$