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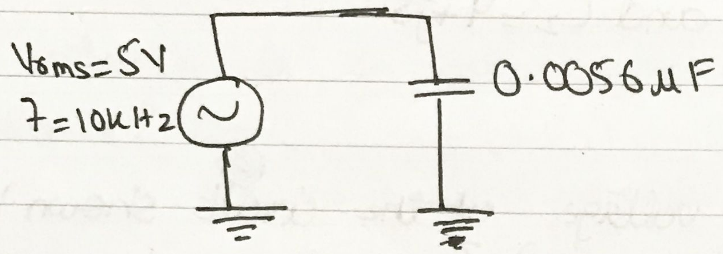
: LECTURE #5 :-

EXAMPLE #1 :-

Determine the rms current :-



Sol :-

First, determine the capacitive reactance :

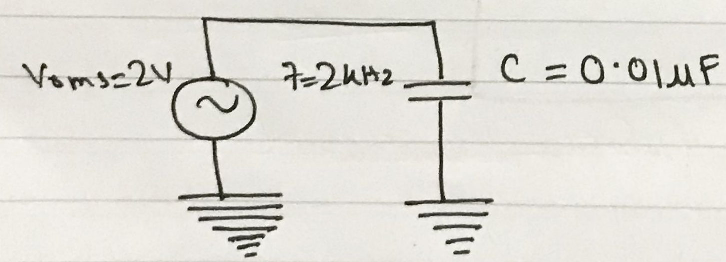
$$X_C = \frac{1}{2\pi f C} = \frac{1}{2\pi(10\times10^3)(0.0056\times10^{-6})} \Rightarrow 2.84k\,\Omega$$

Then apply Ohm's law :-

$$I_{rms} = \frac{V_{rms}}{X_C} \Rightarrow \frac{5V}{2.84k\,\Omega} \Rightarrow 1.76\,mA$$

EXAMPLE #2 :-

Determine the true power and the reactive power :-



Sol :-

The true power P_{true}, is always zero for an ideal capacitor. The reactive power is determined by first finding the value of the capacitive reactance and then using $P_r = \frac{V_{rms}^2}{X_C}$.

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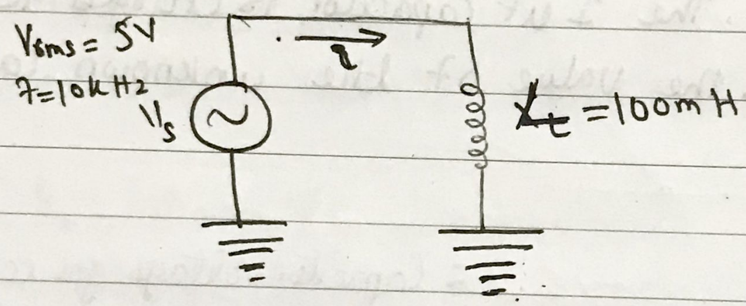
$$X_C = \frac{1}{2\pi f C} = \frac{1}{2\pi(2\times10^3)(0.01\times10^{-6})} \Rightarrow 7.96k\,\Omega$$

$$P_r = \frac{V_{rms}^2}{X_C} = \frac{(2V)^2}{7.96\times10^3} \Rightarrow 503\,\mu VAR$$

EXAMPLE #3:-

Determine the rms current in figure below:



Sol:

$$X_L = 2\pi f L = 2\pi\times(10\times10^3)\times(100\times10^{-3})$$
$$\Rightarrow 6283\,\Omega$$

To determine rms current apply Ohm's law:

$$I_{rms} = \frac{V_{rms}}{X_L} \Rightarrow \frac{5V}{6283} \Rightarrow 796\,\mu A$$

EXAMPLE #4:

A 10Vrms signal with a frequency of 1kHz is applied to a 10mH coil with a negligible winding resistance. Determine the reactive power?

Sol:

First, calculate the inductive reactance and current values.

$$X_L = 2\pi f L = 2\pi(1\times10^3)(10\times10^{-3}) \Rightarrow 62.8\,\Omega$$

$$I = \frac{V_s}{X_L} = \frac{10}{62.8} \Rightarrow 159\,mA$$

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Then,

$$P_r = I^2 X_L = (159\,mA)^2 (62.8\,\Omega) \Rightarrow 1.59\,VAR$$

EXERCISE PROBLEMS:

PROBLEM # 1:

Two series capacitors (one 1 µF, the other of unknown value) are charged from a 12V source. The 1 µF capacitor is charged to 8V and the other to 4V. What is the value of the unknown capacitor?

Sol:

$$V_T = 12V$$

$$V_1 = \left(\frac{C_T}{C_1}\right) V_T \quad \text{: Capacitor voltage for capacitor in series}$$

$$8V = \left(\frac{C_T}{1\times10^{-6}}\right) 12V$$

$$C_T = \left(\frac{8V}{12V}\right) 1\times10^{-6} \Rightarrow 0.666\,\mu F$$

$$V_2 = \left(\frac{C_T}{C_2}\right) V_T$$

$$C_2 = \frac{C_T V_T}{V_2}$$

$$= \frac{0.66\times10^{-6} \times 12V}{4V} \Rightarrow 2\,\mu F$$

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PROBLEM #2:
A sinusoidal voltage of 20Vrms produces an rms current of 100mA when connected to a certain capacitor. What is the reactance?

SOL:

$X_C = ?$

$V_{rms} = 20V_{rms}$

$I_{rms} = 100mA$

$P_r = V_{rms} I_{rms}$

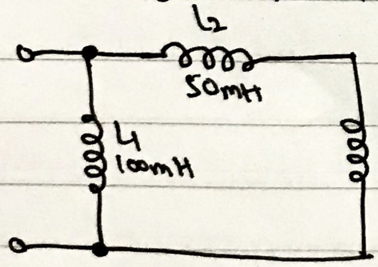
$= 20 \times 100 \times 10^{-3} \Rightarrow 2VAR$

$P_r = I^2_{rms} X_C$

$X_C = \frac{P_r}{I^2_{rms}} = \frac{2VAR}{(100 \times 10^{-3})^2} \Rightarrow 200\Omega$

PROBLEM #3:-
Determine the total inductance of each circuit shown below

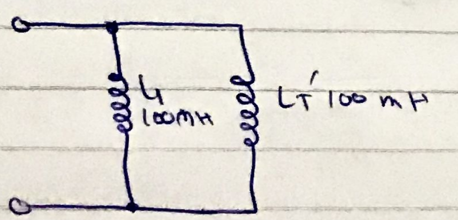
a)



SOL:-

L2 and L3 are in series

$L_T' = L_2 + L_3 \Rightarrow 50mH + 50mH \Rightarrow 100mH$



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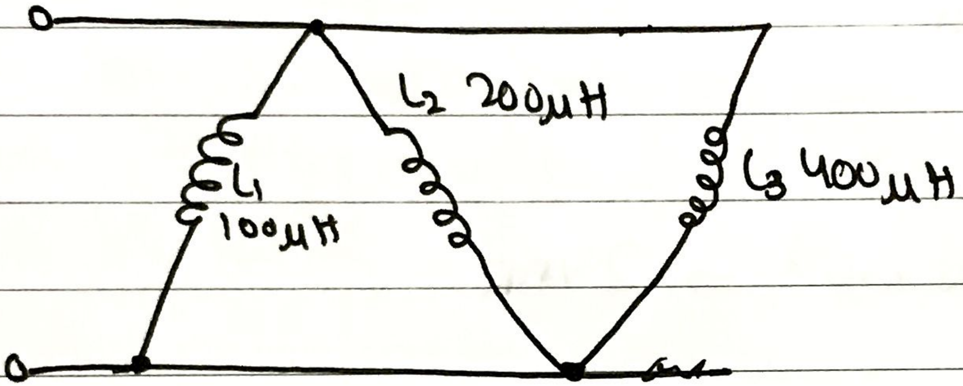
Now, L_T' and L_4 are in parallel.

$$L_T = \frac{1}{\frac{1}{L_T'} + \frac{1}{L_4}} = \frac{1}{\frac{1}{100} + \frac{1}{100}} \Rightarrow 50 \, mH$$

b)



Sol:-

all are in parallel, hence:-

$$L_T = \frac{1}{\frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3}} = \frac{1}{\frac{1}{100} + \frac{1}{200} + \frac{1}{400}} \Rightarrow 57.1 \, \mu H$$