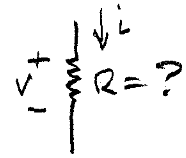
HW #23 Solutions EE301

Ch. 16 #'s 20, 24a, 28b, 29a, 33

16.20) $v = 120V \sin(\omega t + 55°)$

$i = -18mA \cos(\omega t + 145°)$



Show component is resistor and find its resistance.

If we can show that v and i are in phase, the component must be a resistor.

In terms of phasors, voltage can be expressed as

$$V = V_{eff}\angle 55° = (.707)(120V)\angle 55° = 84.8V\angle 55°$$

For current, convert the cosine function into a sine function by a phase shift of 270° from

$$\cos\alpha = \sin(\alpha - 270°)$$

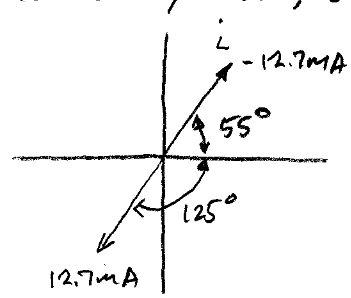
Therefore,

$$i = -18mA \sin(\omega t + 145° - 270°)$$

$$i = -18mA \sin(\omega t - 125°)$$

Drawing this as a phasor, $i = (.707)(-18mA)\angle -125°$

$i = -12.7mA\angle -125°$



We then see that $i = -12.7mA\angle -125°$ is the same as $i = 12.7mA\angle 55°$. Since both v and i are in phase, the component is a resistor.

$$R = \frac{V_m}{I_m} = \frac{120V}{18\times10^{-3}A} = \boxed{6.7k\Omega}$$

16.24) a. $v_L = 100V \sin 377t$, $L = 200mH$

Inductive reactance $X_L = \omega L = (377\,rad/s)(200\times10^{-3}H) = 75.4\Omega$

$$I_m = \frac{V_m}{X_L} = \frac{100V}{75.4\Omega} = 1.33A$$

Since current lags voltage by 90° for an inductor,

$$\boxed{i = 1.33A \sin(377t - 90°)}$$

16.28) b. $e = 100V \sin \omega t$
$C = 5 \mu F$
$f = 1000 Hz$

$i_c = I_m \sin(\omega t + 90°)$ for capacitors, current always leads voltage by 90°

$\omega = 2\pi f = \frac{2\pi \text{ rad}}{\text{cycle}}\left(1000 \frac{\text{cycles}}{\text{sec}}\right) = 6283 \text{ rad/s}$

Capacitive Reactance $X_c = \frac{1}{\omega C}$

$X_c = \frac{1}{(6283 \text{ rad/s})(5 \times 10^{-6} F)} = 31.8\Omega$

$I_m = \frac{V_m}{X_c} = \frac{100V}{31.8\Omega} = 3.14A$

Therefore,

$$\boxed{i_c = 3.14A \sin\left[(6283 \text{ rad/s})t + 90°\right]}$$

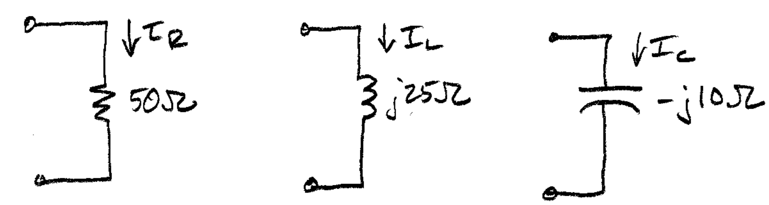
16.29) a. $C = 50 \mu F$
$V_c = 100V \sin 377t$

$X_c = \frac{1}{\omega C} = \frac{1}{(377 \text{ rad/s})(50 \times 10^{-6} F)} = 53.1\Omega$

$I_m = \frac{V_m}{X_c} = \frac{100V}{53.1\Omega} = 1.88A$

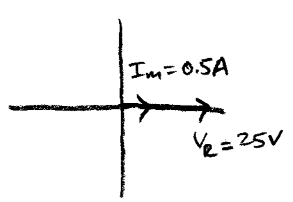
$$\boxed{i_c = 1.88A \sin\left[(377 \text{ rad/s})t + 90°\right]}$$

16.33) $I = 0.5A\angle 0°$ for each component below.



a) In Phasor Form, voltages are for

Resistor: $V_R = I_R Z_R = (0.50A\angle 0°)(50\Omega)$
where Z_R is impedance for resistor.

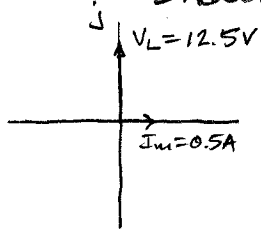


$V_R = (.50A\cos 0° + .50A \sin 0° j)(50\Omega + 0j)$

$V_R = 25V\angle \tan^{-1}\frac{0}{25A} = \boxed{25V\angle 0°}$ same phase as current.

16.33) a. cont'd

Inductor: $V_L = I_L Z_L = (0.5A\angle 0°)(25\Omega j)$

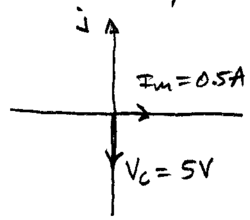


$= (0.50A\cos 0° + 0.50A\sin 0° j)(25\Omega j)$

$= 12.5V j$

$$V_L = 12.5V \angle 90°$$

Capacitor: $V_c = I_L Z_c = (0.5A\angle 0°)(-10\Omega j)$



$= (0.50A\cos 0° + 0.50A\sin 0° j)(-10\Omega j)$

$= -5V j$

$$V_c = 5V \angle -90°$$

b. In time domain, voltages are

$v_R = V_{RM}\sin(\omega t + \theta_R)$

$= \sqrt{2}(25V)\sin(\omega t + 0°)$

$$v_R = 35.4V\sin\omega t$$

$v_L = V_{LM}\sin(\omega t + \theta_L)$

$= \sqrt{2}(12.5V)\sin(\omega t + 90°)$

$$v_L = 17.7V\sin(\omega t + 90°)$$

$v_c = V_{cm}\sin(\omega t + \theta_c)$

$= \sqrt{2}(5V)\sin(\omega t - 90°)$

$$v_c = 7.07V\sin(\omega t - 90°)$$