① AP9.02_9ed

Find the time-domain expression for each phasor below.

The time domain form is assumed to be similar to x(t) = cos(ω t + φ°)

a) V = 18.6 at angle -54° Volts

v(t) = 18.6 ✔ cos (ω t + -54 ✔ °) V

b) I = (20 at angle 45°) - (50 at angle -30°) mA

i(t) = 48.809 ✔ cos (ωt + 126.684 ✔ °) mA

c) V = (20 + j 80) - (30 at angle 15°) Volts

v(t) = 72.790 ✔ cos (ωt + 97.085 ✔ °) V

(a) $18.6 \angle -54^\circ$ $V_m \angle \phi$

$V = 18\cos(\omega t - 54^\circ)\,V$

(b) $20\angle 45^\circ \longrightarrow 20\cos(45^\circ) + j\,20\sin(45^\circ)$

$\longrightarrow 10\sqrt{2} + 10\sqrt{2}j$

$50\angle -30^\circ \longrightarrow 50\cos(-30^\circ) - j\,50\sin(30^\circ)$

$25\sqrt{3} - 25j$

$(20\angle 45^\circ) - (50\angle -30^\circ)$

$(10\sqrt{2} + 10\sqrt{2}j) - (25\sqrt{3} - 25j)$

$-29.159 + 39.142j$ $-x+y$

$A = \sqrt{(-29.159)^2 + (39.142)^2}$

$= 48.809$

$\phi = \tan^{-1}\left[\frac{39.142}{-29.159}\right] = -53.315^\circ$ QUADRANT II

$+180$

$= 126.684^\circ$

$A\angle\phi = 48.809\angle 126.684^\circ$

$i(t) = 48.809\cos(\omega t + 126.684^\circ)\,mA$

(c) $30\angle 15^\circ \longrightarrow 30\cos(15^\circ) + j30\sin(15^\circ)$

$\longrightarrow 28.978 + 7.766j$

$(20 + j\,80) - (28.978 + 7.766j)$

$-8.978 + 72.234j$

$A = \sqrt{(8.978)^2 + (72.234)^2} = 72.790$

$\phi = \tan^{-1}\left[\frac{72.234}{-8.978}\right] = -82.916^\circ$ QII

$+180^\circ = 97.085^\circ$

$A\angle\phi = 72.790\angle 97.085^\circ$

$v(t) = 72.790\cos(\omega t + 97.085^\circ)\,\omega t$

② P9.06_6ed

Use the concept of the phasor to combine the following sinusoidal functions into a single trigonometric express.

The time domain form is assumed to be similar to x(t) = cos(ωt + φ°)

a) x(t) = 100 cos(300 t + 45°) + 500 cos(300 t - 60°)

x(t) = 483.856 ✔ cos (300t + -48.485 ✔ °)

b) y(t) = 250 cos(377 t + 30°) - 150 sin(377 t + 140°)

y(t) = 120.511 ✔ cos (377 t + 4.804 ✔ °)

c) v(t) = 60 cos(100 t + 60°) - 120 sin(100 t - 125°) + 100 cos(100 t + 90°)

v(t) = 152.877 ✔ cos (100 t + 32.942 ✔ °)

d) w(t) = 100 cos(ω t + 40°) + 100 cos(ω t + 160°) + 100 cos(ω t - 80°)

w(t) = 0 ✔ cos (ω t + 0 ✔ °)

(a) $100\angle 45^\circ + 500\angle -60^\circ$

$(50\sqrt{2} + 50\sqrt{2}j) + (250 - 250\sqrt{3}j)$

$320.711 - 362.302j$

$A\angle\phi = 483.856\angle -48.485 \longrightarrow 483.856\angle 311.515^\circ$

(b) $150\sin(377t + 140^\circ) \longrightarrow 155\cos[90^\circ - (377t + 140^\circ)]$

$155\cos(-377t - 50^\circ)$

$155\cos(377t + 50^\circ)$

$250\angle 30^\circ - 150\angle 50^\circ$

$120.088 + j10.093$

$A\angle\phi = 120.511\angle 4.804^\circ$

(c) $120\sin(100t - 125^\circ) \longrightarrow 120\cos(-100t + 215^\circ)$

$120\cos(100t - 215^\circ)$

$60\angle 60^\circ - 120\angle -215^\circ + 100\angle 90^\circ$

$128.298 + 83.132j$

$A\angle\phi = 152.877\angle 32.942^\circ$

(d) $100\angle 40^\circ + 100\angle 160^\circ + 100\angle -80^\circ$

$(76.604 + j\,64.279) + (-93.969 + j\,34.202) + (17.365 - j\,98.481)$

$0 + j0$

$A\angle\phi = 0\angle 0^\circ$

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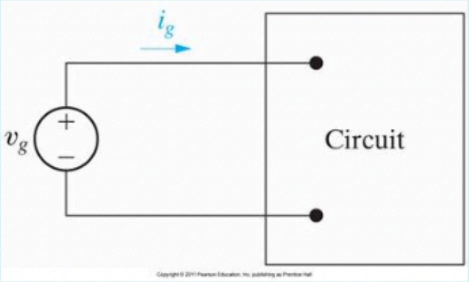

P9.12_9ed

The expressions for the steady-state voltage and current at the terminals of the circuit are

$v_g = 300 \cos(5{,}000\,\pi\,t + 78°)$ V

$i_g = 6 \sin(5{,}000\,\pi\,t + 123°)$ A

a) What is the impedance seen by the source? Write in rectangular form.

Z = 35.35 ✔ +j 35.35 ✔ Ω (Ohm)

b) By how much time t in microseconds is the current out of phase with the voltage?

i_g lags v_g by 50 ✔ μs (micro sec)

(a) V_g : $300 \angle 78°$

i_g : $6 \angle 33°$

$i_g = 6 \sin(500\pi + 123°)$ A

$= 6 \cos(-500\pi - 33°)$ A

$= 6 \cos(500\pi + 33°)$ A

$V = IZ$

$Z = \frac{V}{I} = \frac{300 \angle 78°}{6 \angle 33°} = 50 \angle 45°$

$\longrightarrow 35.35 + 35.35j$

(b) $\omega = 5000\pi$

$\omega = 2\pi / T \longrightarrow T = 2\pi / 5000\pi = 4 \times 10^{-4}$ s $\approx 400\,\mu s$

$t = \frac{45°}{360°} \cdot 400\,\mu s = 50\,\mu s$

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AP9.01_9ed

Find the phasor (based on cosine) transform of each trigonometric function:

a) $v = 170 \cos(377\,t - 40°)$ Volts

V_{phasor} Magnitude = 170 ✔ V

Angle = -40 ✔ ° (Degrees)

b) $i = 10 \sin(1{,}000\,t + 20°)$ Amps

I_{phasor} Magnitude = 10 ✔ A

Angle = -70 ✔ ° (Degrees)

c) $i = 5 \cos(\omega\,t + 36.87°) + 10 \cos(\omega\,t - 53.13°)$ Amps

I_{phasor} Magnitude = 11.18 ✔ A

Angle = -26.57 ✔ ° (Degrees)

d) $v = 300 \cos(20{,}000\,\pi\,t + 45°) - 100 \sin(20{,}000\,\pi\,t + 30°)$ mV

V_{phasor} Magnitude = 339.89 ✔ mV

Angle = 61.51 ✔ ° (Degrees)

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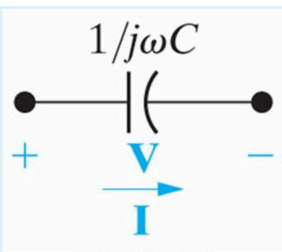

AP9.04_9ed

The voltage across the terminals of the 5 μF (micro F) capacitor is $30 \cos(4{,}000\,t + 25°)$ V.

a) Calculate the capacitive reactance.

X_C = -50 ✔ Ohms

b) Calculate the impedance of the capacitor.

Z_C = j -50 ✔ Ohms

c) Calculate the phasor current **I**.

I = Magnitude 0.60 ✔ with Angle 114.84 ✔ Degrees Amps

d) Write the steady-state expression for i(t).

i(t) = 0.6 ✔ cos (4000 ✔ t + 114.84 ✔ °) Amps

$V = 30\cos(4000t + 25°)$ V

$C = 5\mu F = 5 \times 10^{-6}$ F

$\omega = 4000$

(a) $X_c = \frac{1}{\omega C} = \frac{1}{(4000)(5 \times 10^{-6})} = -50\,\Omega$

(b) $Z_c = \frac{1}{j\omega C} = \frac{1}{j(4000)(5 \times 10^{-6})} = -j50\,\Omega$

(c) $V = 30\cos(4000t + 25°)$ V

$V = 30 \angle 25° \longrightarrow 27.189 + j12.679$

$V = ZI \longrightarrow I = \frac{V}{Z} = \frac{27.189 + j12.679}{-j50} =$

$I = -\frac{0.54378}{j} - 0.25358$

$= j0.54 - 0.25 \approx -0.25 + j0.54$

$I = 0.60 \angle 114.84°$

(d) $i = \frac{30}{-j50} \cos(4000t + 25°)$

$i = 0.6\cos(4000t + 114.84°)$

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P9.12_8ed

A 50 Hz sinusoidal voltage with a maximum amplitude of 340 V at t = 0 is applied across the terminals of an inductor. The maximum amplitude of the steady-state current in the inductor is 8.5 A.

a) What is the frequency of the inductor current?

ω = 314.16 ✔ rad/sec

b) If the phase angle of the voltage is zero, what is the phase angle of the current?

Φ_I = -90 ✔ ° (Degree)

c) What is the reactance of the inductor?

X_L = 40 ✔ Ω (Ohm)

d) What is the inductance of the inductor?

L = 127.32 ✔ mH (milli H)

(a) $f = 50\ \text{Hz}$

$\omega = 2\pi f = 2\pi(50) = 100\pi \approx 314.16\ \text{rad/s}$

(b) $\phi_V = 0$

$\phi_I = -90°$

(b)

The phase angle of inductor voltage, $\phi_v = 0°$

Since the current through the inductor lags behind the voltage by exactly 90°, the phase angle of the current, ϕ_i is $-90°$.

(c) $V = 340\angle 0°\ \text{V}$

$I = 8.5\angle -90°\ \text{A}$

$$Z_L = \frac{V}{I} = \frac{340\angle 0°}{8.5\angle -90°} = 40\angle 90° \approx 0 + j40\ \Omega$$

$Z_L = jX_L \longrightarrow X_L = 40$

(d) $jX_L = j\omega L$

$L = X_L/\omega = 40/100\pi = 0.12732 \approx 127.32\ \text{mH}$

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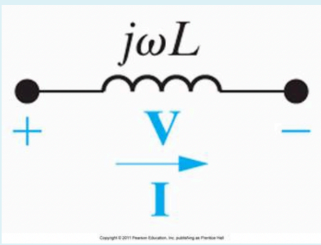

AP9.03_9ed

The current in the inductor is 10 cos (10,000 t + 30°) mA.

Given: L = 20 mH

a) Calculate the inductance reactance.

X_L = 200 ✔ Ω (Ohm)

b) Calculate the impedance of the inductor.

Z_L = j 200 ✔ Ω (Ohm)

c) Calculate the phasor voltage **V**.

V = Magnitude 2 ✔ with Angle 120 ✔ ° (Degrees) Volts

d) Write the steady-state expression for v(t).

v(t) = 2 ✔ cos (10000 ✔ t + 120 ✔ °) Volts

(a) $X_L = \omega L = (10\,000)(20\times 10^{-3})$

$= 200$

(b) $Z_L = j\omega L = jX_L = j200$

(c) $V = ZI$

$= (j200)[(10\angle 30°)\times 10^{-3}]$

$= (j200)[(5\sqrt{3} + j5)\times 10^{-3}] = (j1000\sqrt{3} + 1000)\times 10^{-3}$

$= 1 + j\sqrt{3} \approx 3\angle 60°$

(d) $v(t) = 1000\cos(10000t + 89.50°)$