① Ex9.01_9ed

A sinusoidal current has maximum amplitude of I_{peak} = 90 A.

The current passes through one complete cycle in T = 11.50 ms (milli sec).

a) What is the rms value of the current?

I_{rms} = 63.64 ✔ A_{rms}

b) What is the frequency f in hertz?

f = 86.96 ✔ Hz

c) What is the frequency ω in radians per second?

ω = 546.36 ✔ rad/sec

$I_{peak} = 90$ A

$T = 11.50$ ms ≈ 0.0115 s

(a) $I_{rms} = \frac{I_{peak}}{\sqrt{2}} = \frac{90}{\sqrt{2}} = 63.64$ A

(b) $f = \frac{1}{T} = 86.96$ Hz

(c) $\omega = \frac{2\pi}{T} = \frac{2\pi}{0.0115} = 546.36$ rad/s

② P9.03_9ed

A sinusoidal current is zero at t = -625 μs (micro sec) and increasing at a rate of 8,000 π (pi) A/sec [Hint: rate of current change = di/dt].

The maximum amplitude of the current is 20 A.

a) What is the frequency of i(t) in radians per second?

ω (omega) = 1256.64 ✔ rad/sec

b) What the following parameters of the current i(t) cosine form expression?

The period of the current source?

T = 5 ✔ ms (millisec)

The phase angle φ_i (phi_i)?

φ_i (phi_i) = -45 ✔ ° (Degrees)

$i(t) = I_m \sin(\omega t + \phi)$

$\frac{di}{dt} = \omega I_m \cos(\omega t + \phi)$

@ $t = 625\ \mu s$ $di/dt = 8000\pi$ A/s

$8000\pi = \omega I_m$

$8000\pi = \omega(20)$

$\omega = 400\pi$

$\omega = 2\pi/T \longrightarrow T = 2\pi/\omega = 2\pi/400\pi = 5\times10^{-3}\,s \approx 5$ ms

③ P9.02_9ed

At t = -2 ms (milli sec), a sinusoidal voltage is known to be zero and going positive.

[Hint: The easiest representation of the waveform at t = -2 ms is the sine and not the cosine form.]

The voltage is next zero at t = 8 ms (millisec).

It is also known that the voltage is 80.9V at t = 0.

a) What is the frequency of v(t) in hertz?

f = 50 ✔ Hz

b) What are the following parameters of the voltage v(t)in the cosine form expression?

The frequency of the voltage source?

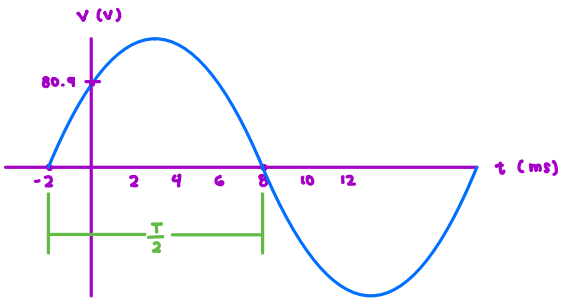
w (omega) = 314.159 ✔ radians/sec

The phase angle φ_v (phi_v)?

φ_v (phi_v) = -54 ✔ ° (Degree)

The maximum voltage V_m?

V_m = 137.635 ✔ V



$\frac{T}{2} = 8 - (-2) = 20$ ms $\approx 20\times10^{-3}$ s

(a) $f = 1/T = 1/20\times10^{-3} = 50$ Hz

(b) $\omega = 2\pi f = 2\pi(50) = 100\pi$

$180° = 10$ $\quad \frac{180}{10} = \frac{\phi}{2}$

$\phi = 2$ $\quad \phi = 36°$

$v(t) = V_m \sin(\omega t + \phi)$

$v(t) = V_m \sin(100\pi t + 36°)$

$v(t) = V_m \cos(100\pi t + 36° - 90°)$

$= V_m \cos(100\pi t - 54°)$ $\quad \phi = -54°$

@ $v(0) = 80.9$ V

$80.9 = V_m \cos(-54)$

$V_m = 137.635$ V

④ T9.04

Given v(t) = 100 sin(500 t - 23°) Volts

a) Translate the voltage into the cosine form.

v(t) = 100 ✔ cos(500 ✔ t + -113 ✔ °) Volts

b) Find the rms value of the voltage.

V_{rms} = 70.71 ✔ Vrms

c) Find the voltage v(t) at t = 5 ms (milli sec).

v(t = 5 ms) = 86.39 ✔ V

$v(t) = 100\sin(500t - 23°)$

cosine form:

(a) $v(t) = 100\cos(500t - 23° - 90°)$

$v(t) = 100\cos(500t - 113°)$

(b) $V_{rms} = V_m/\sqrt{2} = 100/\sqrt{2} = 70.71$

(c) @ $t = 5ms \approx 5\times10^{-3}s$

$v = 100\sin[500(5\times10^{-3}) - 23°]$

$v = 100\sin(2.5 - 0.4014)$

$= 86.39\ V$

⑤ P9.03_6ed

Consider the sinusoidal voltage v(t) = 170 cos(120 π t - 60°) V. v(t) without symbols is (170 cos(120 pi t – 60 degrees)

a) What is the maximum amplitude of the voltage? V_m = 170 ✔ V

b) What is the frequency of v(t) in hertz? f = 60 ✔ Hz

c) What is the frequency of v(t) in radians per second?

ω (omega) = 376.99 ✔ rad/sec

d) What is the phase angle in radians? φ (phi) = -1.047 ✔ radians

e) What is the phase angle in degrees? φ (phi) = -60 ✔ ° (Degrees)

f) What is the period in milliseconds? T = 16.67 ✔ ms (milli sec)

g) What is the first time after t = 0 that v(t) = 170V? t = 2.77 ✔ ms (milli sec)

$v(t) = 170\cos(120\pi t - 60°)$

$v(t) = V_m\cos(\omega t + \phi)$

(a) $V_m = 170\ V$

(b) $\omega = 2\pi f \longrightarrow f = \omega/2\pi = 120\pi/2\pi = 60\ Hz$

(c) $\omega = 120\pi \approx 376.99\ rad/s$

(d) $\phi = -60° \approx -\pi/3 + 2\pi = \frac{5}{3}\pi$

(e) $\phi = -60°$

(f) $\omega = 2\pi/T \longrightarrow T = 2\pi/\omega = 2\pi/120\pi = 0.01667 \approx 16.67\ ms$

(g) @ $v(t) = 170V$

$170 = 170\cos(120\pi t - 60°)$

$1 = \cos(120\pi t - 60°)$

$0 = 120\pi t - \pi/3$

$t = \frac{1}{360} \approx 0.00278s \approx 2.778\ ms$

⑥ P9.01_8ed

Consider the sinusoidal voltage v(t) = 100 cos(240 p t + 45°) mV.

a) What is the maximum amplitude of the voltage? V_m = 100 ✔ mV

b) What is the frequency of v(t) in hertz? f = 120 ✔ Hz

c) What is the frequency of v(t) in radians per second?

w (omega) = 753.98 ✔ rad/sec

d) What is the phase angle in radians? f (phi) = 0.7854 ✔ radians

e) What is the phase angle in degrees? f (phi) = 45 ✔ ° (Degree)

f) What is the period in milliseconds? T = 8.333 ✔ ms (milli sec)

g) What is the first time after t = 0 that v(t) = 100 mV?

t = 7.292 ✔ ms (milli sec)

$v(t) = 100\cos(240\pi t + 45°)\ mV$

$v(t) = V_m\cos(\omega t + \phi)$

(a) $V_m = 100\ mV$

(b) $\omega = 2\pi f \qquad f = \frac{\omega}{2\pi} = \frac{240\pi}{2\pi} = 120\ Hz$

(c) $\omega = 240\pi \approx 753.98\ rad/s$

(d) $\phi = 45° \rightarrow \pi/4 \approx 0.7854\ rad$

(e) $\phi = 45°$

(f) $\omega = 2\pi/T \longrightarrow T = 2\pi/\omega = 2\pi/240\pi = 0.008\overline{333}\ s \approx 8.333\ ms$

(g) @ $v(t) = 100mV$

$100 = 100\cos(240\pi t + 45°)$

$2\pi = 240\pi t + \pi/4$

$t = \frac{7}{960} \approx 0.007292\ s \approx 7.292\ ms$

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T9.03

Given $v(t) = 53\cos(1{,}000\,t + 73°)$ Volts

a) Find the frequency in hertz for this voltage.

f = 159.15 ✔ Hz

a) Find the rms value of the voltage.

V_{rms} = 37.48 ✔ Vrms

c) Find the voltage v(t) at t = 2 ms (milli sec).

v(t = 2 ms) = -52.53 ✔ V

$v(t) = 53\cos(1000t + 73°)$

(a) $\omega = 2\pi f$

$f = \frac{\omega}{2\pi} = \frac{1000}{2\pi} = 159.15\ Hz$

(b) $V_{rms} = \frac{V_m}{\sqrt{2}} = \frac{53}{\sqrt{2}} = 37.48\ V$

(c) @ $t = 2ms \approx 2\times10^{-3}\,s$

$v = 53\cos\left[1000(2\times10^{-3}) + \frac{73}{180}\pi\right]$

$v = -52.53\ V$

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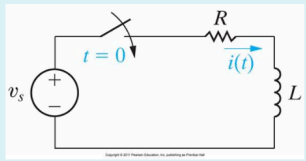


P9.09_8ed

The voltage applied to this circuit at t = 0 (when the switch closes) is $v_s(t) = 100\cos(400\,t + 60°)$ Volts

Also given that R = 40 Ω (Ohm) and L = 75 mH (milli H)

The initial inductor current is zero for t < 0⁻.

The textbook gives you the total response equation as:

$$i(t) = i_{transient}(t) + i_{steady\_state}(t) = \frac{-V_m}{\sqrt{R^2+(\omega L)^2}}\cos(\phi-\theta)e^{-(\frac{R}{L})t} + \frac{V_m}{\sqrt{R^2+(\omega L)^2}}\cos(\omega t+\phi-\theta)$$

Where $\theta = \tan^{-1}\left(\frac{\omega L}{R}\right)$ and $v(t) = V_m\cos(\omega t + \Phi)$ Volts

For t = 750 μsec (micro sec) after the switch closed, find the following values.

a) Find the numerical value of the transient response of i.

$i_{transient}$ (at t = 750μs) = -1.2329 ✔ A

b) Find the numerical value of the steady state response of i.

i_{steady_state} (at t = 750μs) = 1.5249 ✔ A

c) Find the total response i.

i_{total} (at t = 750μs) = 0.2920 ✔ A

$v_s = 100\cos(400t + 60°)\ V$

$R = 40\Omega,\ L = 75mH$

$\theta = \tan^{-1}\left(\frac{\omega L}{R}\right) = \tan^{-1}\left[\frac{(400)(75\times10^{-3})}{40}\right]$

$\theta = 36.870°$

$i_{transient} = -\frac{V_m}{\sqrt{R^2+(\omega L)^2}}\cos(\phi-\theta)e^{-(R/L)t}$

$= -\frac{100}{\sqrt{2500}}\cos(60-36.870)e^{-(1600/3)(750\times10^{-6})}$

$= -2\cos(23.13)e^{-0.4} = -1.2329$

$i_{steady-state} = \frac{V_m}{\sqrt{R^2+(\omega L)^2}}\cos(\omega t+\phi-\theta)$

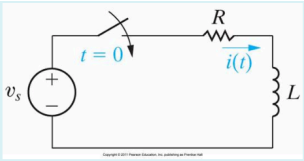
$= \frac{100}{\sqrt{2500}}\cos\left[(400)(750\times10^{-6}) + 60 - 36.870\right]$

$= 2\cos(0.3 + 23.13°)$

$= 1.5249$

$i(t) = i_{transient} + i_{steady.state} = 0.2920$

(9)



P9.09_10ed

The voltage applied to this circuit at t = 0 (when the switch closes) is $v_s(t) = 75 \cos(4{,}000t - 60°)$ Volts

Also given that R = 400 Ω (0hm) and L = 75 mH (milli Henry)

The initial inductor current is zero for t < 0.

The textbook gives you the total response equation as:

$$i(t) = i_{transient}(t) + i_{steady\_state}(t) = \frac{-V_m}{\sqrt{R^2+(\omega L)^2}}\cos(\phi-\theta)e^{-(\frac{R}{L})t} + \frac{V_m}{\sqrt{R^2+(\omega L)^2}}\cos(\omega t+\phi-\theta)$$

Where $\theta = \tan^{-1}\left(\frac{\omega L}{R}\right)$ and v(t) = Vm cos (ω t + Φ) Volts

For t = 750 μsec (micro sec) after the switch closed, find the following values.

a) Find the numerical value of the transient response of i.

$i_{transient}$ = 0.33 ✔ mA (milli Amp)

b) Find the numerical value of the steady state response of i.

i_{steady_state} = 38.5 ✔ mA (milli Amp)

c) Find the total response i.

i_{total} = 38.83 ✔ mA (milli Amp)

$v_s = 75\cos(4000t - 60°)$ V

$R = 400\,\Omega$, $L = 75$ mH

$$\theta = \tan^{-1}\left(\frac{\omega L}{R}\right) = \tan^{-1}\left[\frac{(4000)(75\times10^{-3})}{400}\right]$$

$\theta = 36.87°$

$$i_{transient} = -\frac{V_m}{\sqrt{R^2+(\omega L)^2}}\cos(\phi-\theta)e^{-(R/L)t}$$

$$= -\frac{75}{500}\cos(-60°-36.87°)e^{-(400/75\times10^{-3})(750\times10^{-6})}$$

$$= -0.15\cos(-96.87°)e^{-4} = 0.0003286\text{ A} \approx 0.3286\text{ mA}$$

$$i_{steady\_state} = \frac{V_m}{\sqrt{R^2+(\omega L)^2}}\cos(\omega t+\phi-\theta)$$

$$= \frac{100}{500}\cos[(4000)(750\times10^{-6}) - 60° - 36.87°]$$

$$= 0.15\cos(3-96.87°) = 0.03878\text{ A} \approx 38.78\text{ mA}$$

$i(t) = i_{transient} + i_{steady\_state} = 39.11$ mA