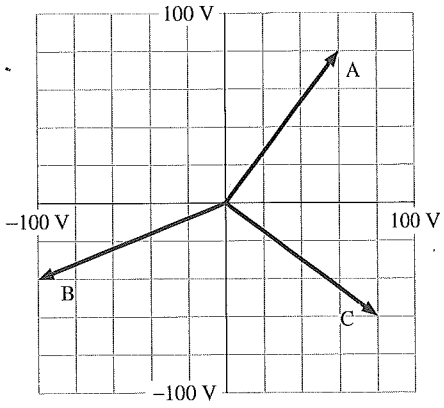
36 AC Circuits

36.1 AC Sources and Phasors

1. The figure shows emf phasors A, B, and C.



   a. What is the instantaneous value of the emf? x-axis proj.

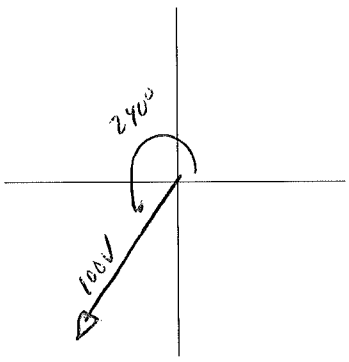
   A 60 V B −100 V C 80 V

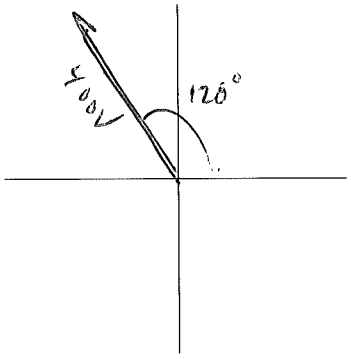
   b. At this instant, is the magnitude of the emf increasing, decreasing, or holding constant?

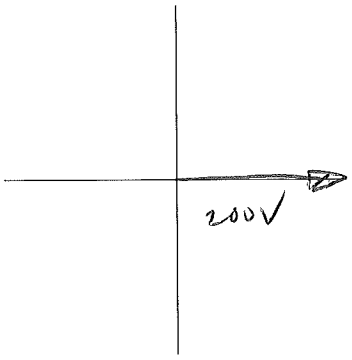
   A dec. B dec C incr.

2. Draw a phasor diagram for the following emfs.

   a. $(100\text{ V})\cos\omega t$ at $\omega t = 240°$ b. $(400\text{ V})\cos\omega t$ at $t = \frac{1}{3}T$ c. $(200\text{ V})\cos\omega t$ at $t = 0$



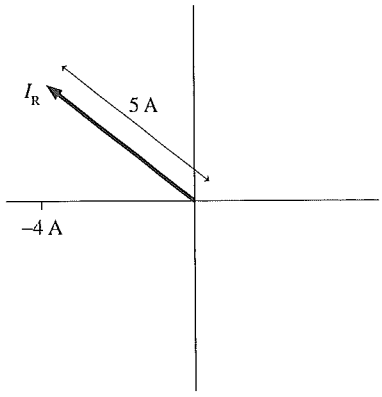




3. The current phasor is shown for a 10 Ω resistor.

   a. What is the instantaneous resistor voltage v_R?

   $i = -4\text{ A}$ $V = iR = 40\text{ V}$.



   b. What is the peak resistor voltage V_R?

   $i_p = 5\text{ A}$ $V = iR = 50\text{ V}$

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4. The peak current through a resistor is 4.0 A. What is the peak current if:

   a. The resistance R is doubled?

   $V = IR$ $\quad R \uparrow 2x \quad I \downarrow 2x$ (2 A.)

   b. The peak emf $\mathcal{E}_0$ is doubled?

   $I \uparrow 2x.$ (8 A)

   c. The frequency ω is doubled?

   (4 A) No effect.

36.2 Capacitor Circuits

5. The peak current through a capacitor is 4.0 A. What is the peak current if:

   a. The peak emf $\mathcal{E}_0$ is doubled?

   $V = IX \quad X = \frac{1}{\omega C} \quad \mathcal{E} = V = \frac{I}{\omega C}$ $\quad \mathcal{E} \uparrow 2x \Rightarrow I \uparrow 2x$ (8 A)

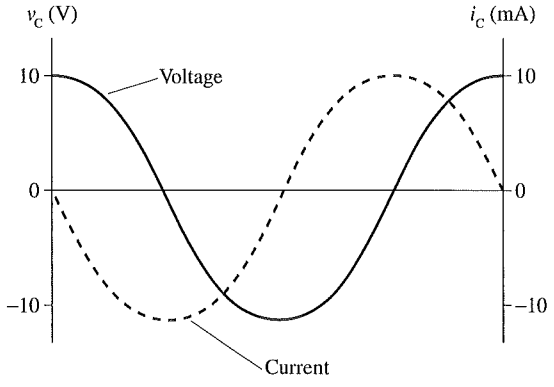
   b. The capacitance C is doubled?

   $C \uparrow 2x \Rightarrow I \uparrow 2x.$ (8 A)

   c. The frequency ω is doubled?

   $\omega \uparrow 2x \Rightarrow I \uparrow 2x$ (8 A)

6. Current and voltage graphs are shown for a capacitor circuit with $\omega = 1000$ rad/s.



   a. What is the capacitive reactance X_C?

   $V = iX_C \quad X_C = \frac{10V}{10\,mA} = 1\,k\Omega.$

   b. What is the capacitance C?

   $X_L = \frac{1}{\omega C} = 1\,k\Omega$

   $C = 10^{-6}\,F. = 1\,\mu F$

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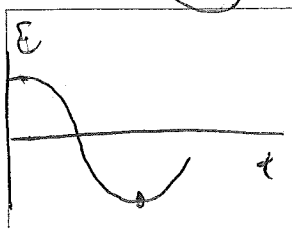
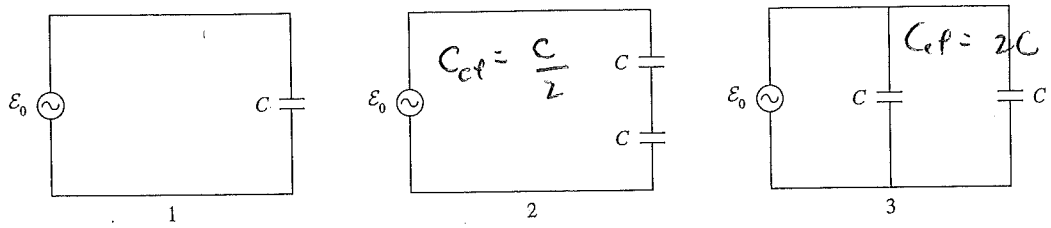
7. A 13 μF capacitor is connected to a 5.5 V/250 Hz oscillator. What is the instantaneous capacitor current i_C when $\mathcal{E} = -5.5$ V?



i 90° out of phase, so i = 0 !

8. Consider these three circuits.

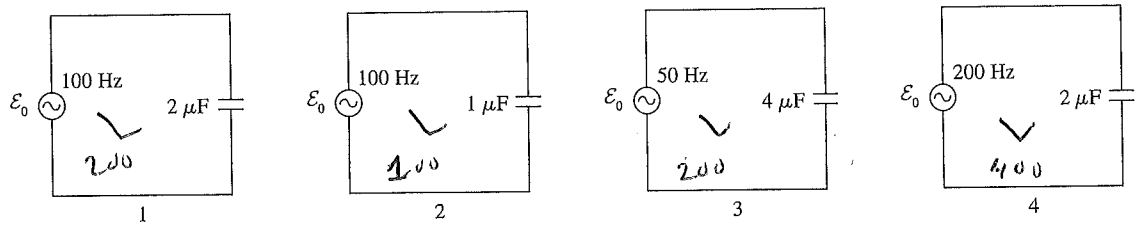


Rank in order, from largest to smallest, the peak currents $(I_C)_1$ to $(I_C)_3$ provided by the emf.

Order: 3, 1, 2

Explanation:

9. Consider these four circuits.



Rank in order, from largest to smallest, the capacitive reactances $(X_C)_1$ to $(X_C)_4$.

Order: 2, 1 = 3, 4

Explanation:

$X_C = \frac{1}{\omega C}$

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36.4 Inductor Circuits

14. The peak current passing through an inductor is 4.0 A. What is the peak current if:

a. The peak emf $\mathcal{E}_0$ is doubled?

8A. $V = IX_L$ $X_L = \omega L$.

$V = I\omega L$.

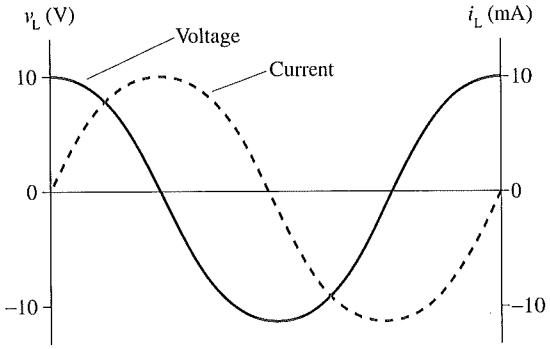
b. The inductance L is doubled?

$L \uparrow 2x$. $I \downarrow 2x$. 2A

c. The frequency ω is doubled?

$\omega \uparrow 2x$ $I \downarrow 2x$ 2A

15. Current and voltage graphs are shown for an inductor circuit with $\omega = 1000$ rad/s.



a. What is the inductive reactance X_L?

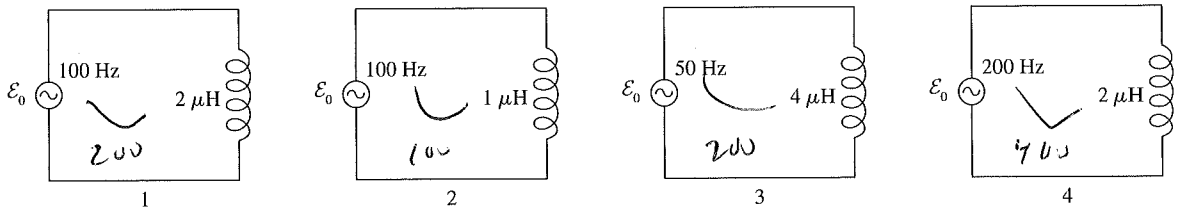
$X_L = \frac{V}{I} = \frac{10V}{10mA} = 1k\Omega$

b. What is the inductance L?

$X_L = \omega L = 1000\ s^{-1} \cdot ?\ L$

$L = 1\ H$

16. Consider these four circuits.



Rank in order, from largest to smallest, the inductive reactances $(X_L)_1$ to $(X_L)_4$.

Order: 4, 1=3, 2.

Explanation:

$X_L = \omega L$.

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36.5 The Series *RLC* Circuit

17. The resonance frequency of a series *RLC* circuit is 1000 Hz. What is the resonance frequency if:

a. The resistance R is doubled?

$\omega_0 = \frac{1}{\sqrt{LC}}$

1000 Hz

b. The inductance L is doubled?

707 Hz

c. The capacitance C is doubled?

707 Hz

d. The peak emf $\mathcal{E}_0$ is doubled?

1000 Hz.

e. The frequency ω is doubled?

1000 Hz.

18. For these combinations of resistance and reactance, is a series *RLC* circuit in resonance (Yes or No)? Does the current lead the emf, lag the emf, or is it in phase with the emf?

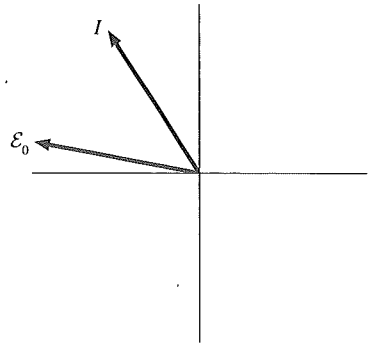
R	X_L	X_C	Resonance?	Current?
100 Ω	100 Ω	50 Ω	no	i lags V, L dominates
100 Ω	50 Ω	100 Ω	no	i leads V, C dominates
100 Ω	75 Ω	75 Ω	yes	in phase

19. In this series *RLC* circuit, is the emf frequency less than, equal to, or greater than the resonance frequency ω_0? Explain.

V leads i, inductor dominates.

ωL is "too big"

$\omega > \omega_0$



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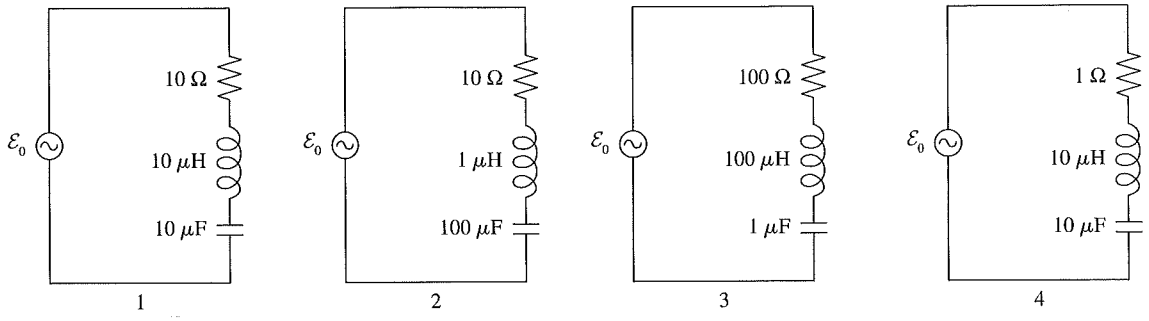
20. The resonance frequency of a series *RLC* circuit is greater than the emf frequency. Does the current lead or lag the emf? Explain.

ωL is too small ($< \omega_0 L$)

$\frac{1}{\omega C}$ is too big. Cap dominates V lags i.

i leads V, (or $\mathcal{E}$)

21. Consider these four circuits. They all have the same resonance frequency ω_0.



Rank in order, from largest to smallest, the maximum currents $(I_{max})_1$ to $(I_{max})_4$.

Order: 4, 1=2, 3

Explanation:

Smaller R, ↑ i

22. The current in a series *RLC* circuit lags the emf by 20°. You cannot change the emf. What two different things could you do to the circuit that would increase the power delivered to the circuit by the emf?

V leads i, inductor dominates.

you could decrease L

or decrease C

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36.6 Power in AC Circuits

23. An average power dissipated by a resistor is 4.0 W. What is P_{avg} if:

a. The resistance R is doubled?

$P = \frac{V^2}{R}$ $R \uparrow 2x$, $P \downarrow 2x$ (2W)

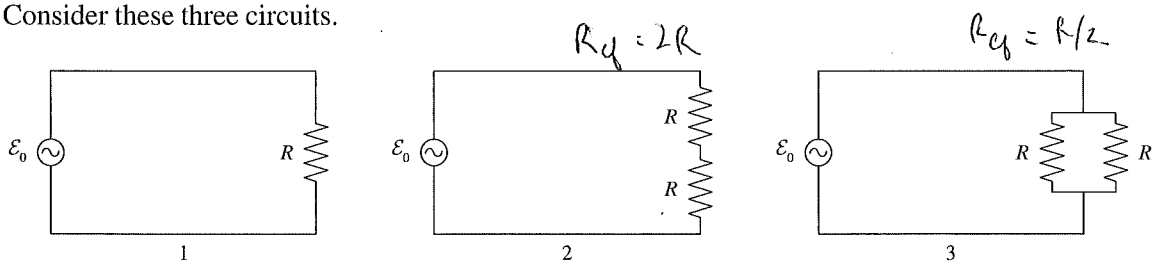
b. The peak emf $\mathcal{E}_0$ is doubled?

$V \uparrow 2x$, $V^2 \uparrow 4x$, $P \uparrow 4x$ (16W)

c. Both are doubled simultaneously?

8W

24. Consider these three circuits.



Rank in order, from largest to smallest, the average powers P_1 to P_3 delivered by the three emfs.

Order: 3, 1, 2

Explanation:

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