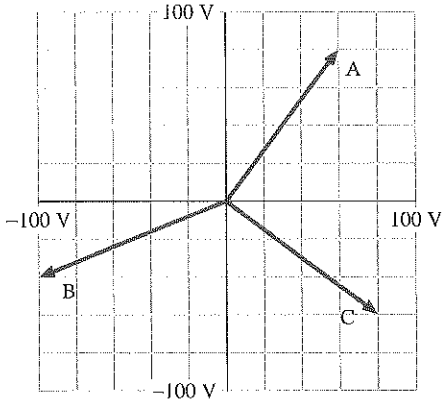
35 AC Circuits

35.1 AC Sources and Phasors

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



   a. What is the instantaneous value of the emf?

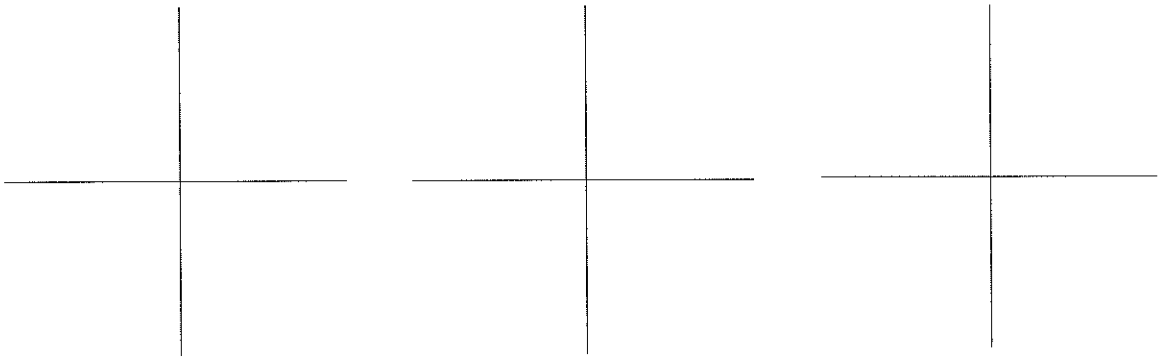
   A _____ B _____ C _____

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

   A _____ B _____ C _____

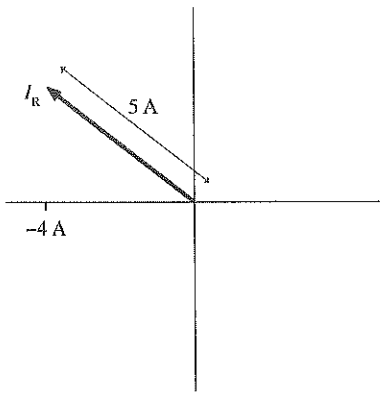
2. Draw a phasor diagram for the following emfs.

   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?



   b. What is the peak resistor voltage V_R?

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4. A circuit consists of one resistor connected to an emf. The peak current through the resistor is 4.0 A. What is the peak current if:

   a. The resistance R is doubled?

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

   c. The frequency ω is doubled?

35.2 Capacitor Circuits

5. A circuit consists of one capacitor connected to an emf. The peak current through the capacitor is 4.0 A. What is the peak current if:

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

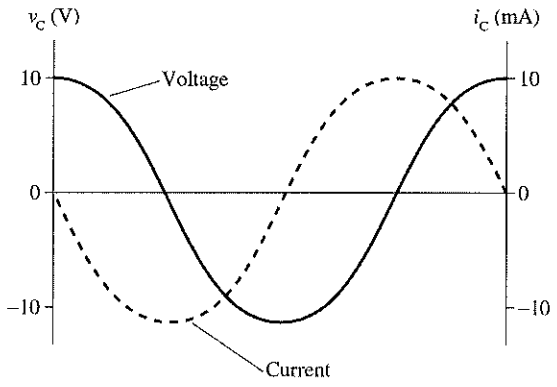
   b. The capacitance C is doubled?

   c. The frequency ω is doubled?

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

   a. What is the capacitive reactance X_C?

   b. What is the capacitance C?



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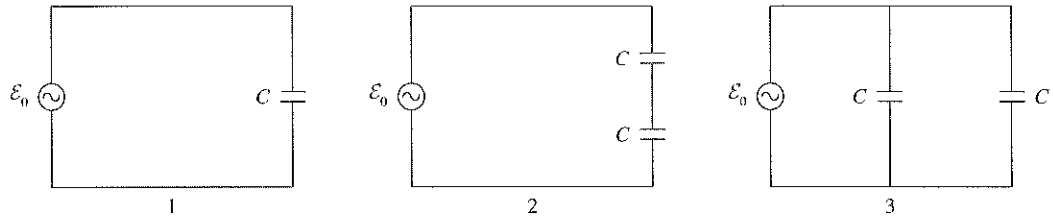
7. A 13 μF capacitor is connected to a 5.5 V/250 Hz oscillator. What is the instantaneous capacitor current i_C when $\mathcal{E} = -5.5$ V?

8. Consider these three circuits.

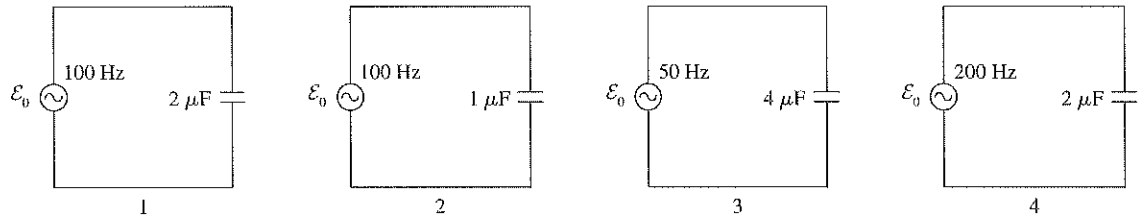


Rank in order, from largest to smallest, the peak currents $(I_C)_1$ to $(I_C)_3$ provided by the emf.

Order:

Explanation:

9. Consider these four circuits.



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

Order:

Explanation:

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35.3 *RC* Filter Circuits

10. A low-pass *RC* filter has a crossover frequency $f_c = 200$ Hz. What is f_c if:

    a. The resistance R is halved?

    b. The capacitance C is halved?

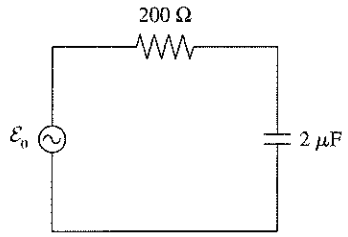
    c. The peak emf $\mathcal{E}_0$ is halved?

11. What new resistor value R will give this circuit the same value of ω_c if the capacitor value is changed to:

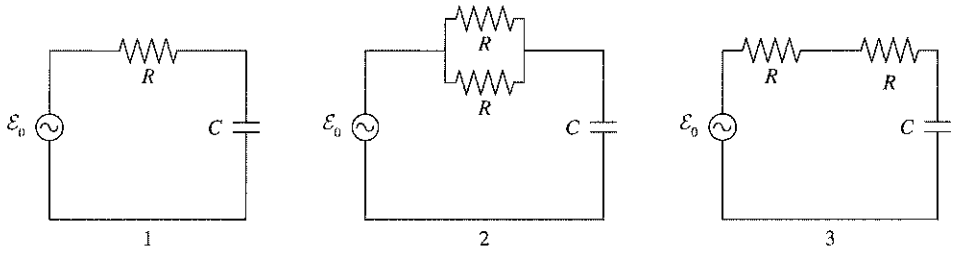
    a. $C = 1\ \mu$F $\quad R =$ _____

    b. $C = 4\ \mu$F $\quad R =$ _____

    c. $C = 20\ \mu$F $\quad R =$ _____



12. Consider these three circuits.



    Rank in order, from largest to smallest, the crossover frequencies ω_{c1} to ω_{c3}.

    Order:

    Explanation:

13. The text claims that $V_R = V_C = \mathcal{E}_0/\sqrt{2}$ at $\omega = \omega_c$. If this is true, then $V_R + V_C > \mathcal{E}_0$. Is it possible for their sum to be larger than $\mathcal{E}_0$? Explain.

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35.4 Inductor Circuits

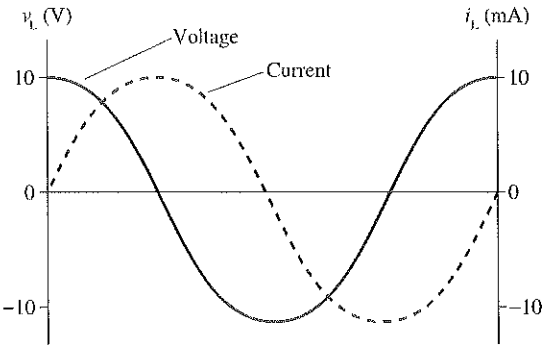
14. A circuit consists of one inductor connected to an emf. The peak current through the inductor is 4.0 A. What is the peak current if:

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

b. The inductance L is doubled?

c. The frequency ω is doubled?

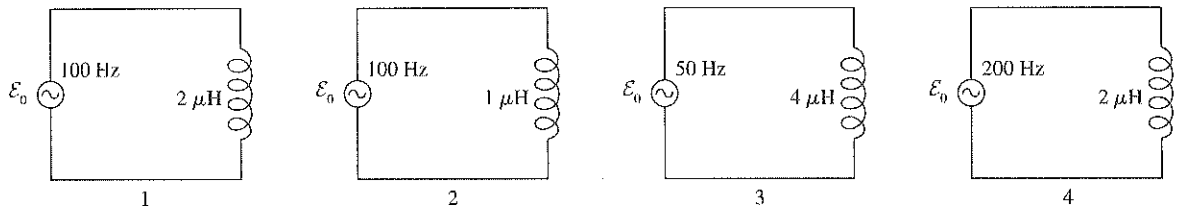
15. Current and voltage graphs are shown for an inductor circuit with $\omega = 1000$ rad/s.



a. What is the inductive reactance X_L?

b. What is the inductance L?

16. Consider these four circuits.



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

Order:

Explanation:

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35.5 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?

b. The inductance L is doubled?

c. The capacitance C is doubled?

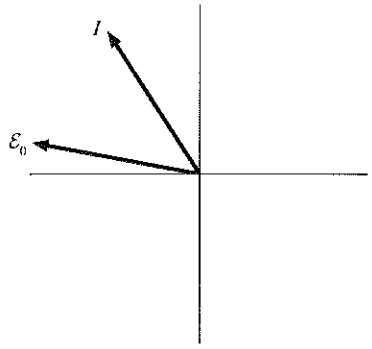
d. The peak emf $\mathcal{E}_0$ is doubled?

e. The frequency ω is doubled?

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		
100 Ω	50 Ω	100 Ω		
100 Ω	75 Ω	75 Ω		

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



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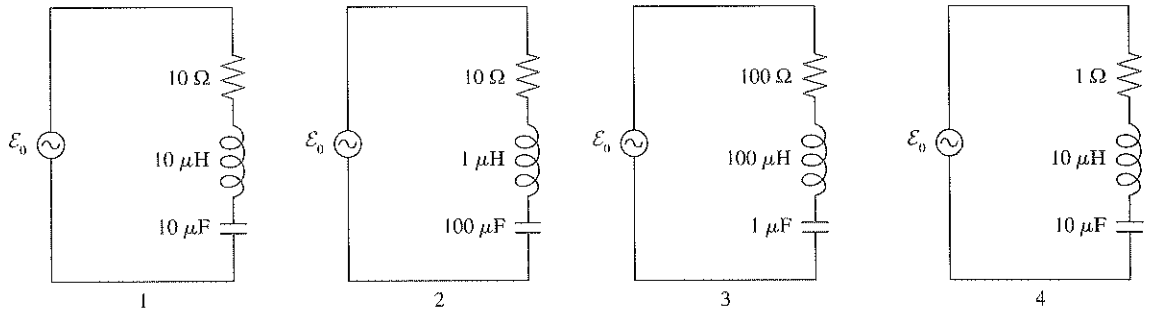
20. The resonance frequency of a series *RLC* circuit is greater than the emf frequency. Does the current lead or lag the emf? Explain.

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:

Explanation:

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?

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35.6 Power in AC Circuits

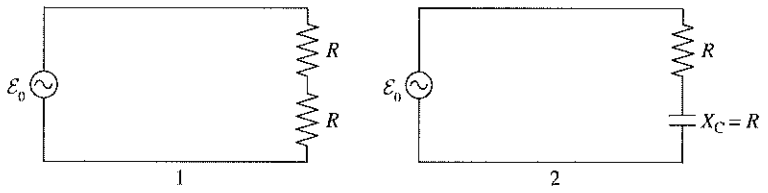
23. An average power dissipated by a resistor in an all-resistor circuit is 4.0 W. What is P_{avg} if:

a. The resistance R is doubled?

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

c. The frequency is doubled?

24. Consider these two circuits.



a. Which has the larger peak current? Or do both have the same peak current?

b. In which does the emf supply the larger power? Or do both supply the same power?

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