Concept Q.: RLC Circuit w/ Light bulb

As I slide the core into the inductor the light bulb changes brightness. Why?

I am driving the circuit through resonance by…

1. continuously increasing the frequency of current oscillations in the circuit
2. continuously decreasing the frequency of current oscillations in the circuit
3. continuously increasing the natural frequency of oscillations in the circuit
4. continuously decreasing the natural frequency of oscillations in the circuit
5. I don't know

Concept Question Answer: RLC Light Bulb

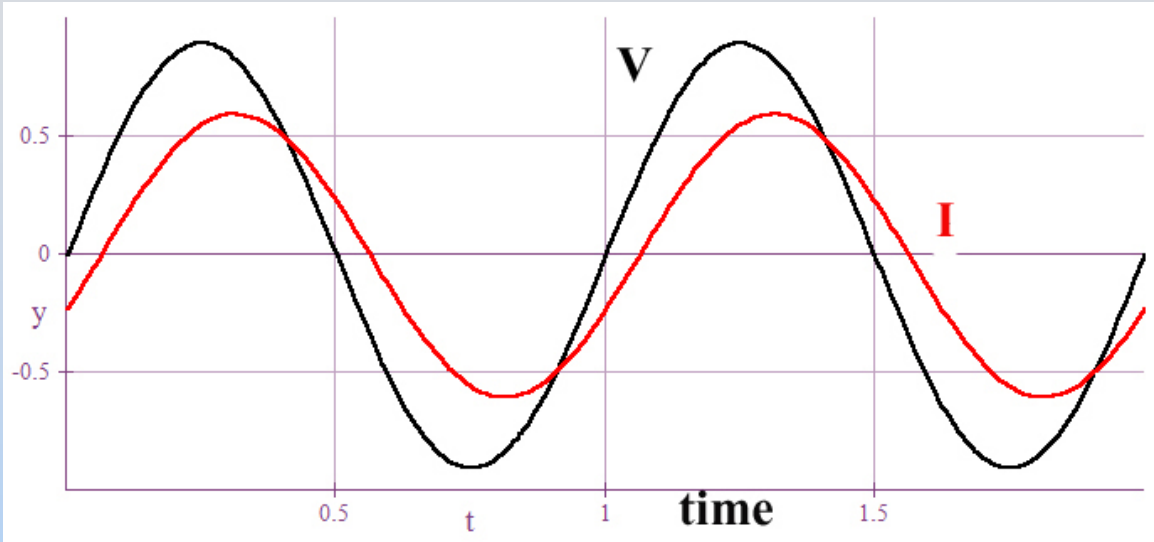
Answer:

4. I am decreasing the natural frequency

Putting in a core increases the inductor's inductance and hence decreases the natural frequency of the circuit. As this sweeps through the 60 Hz drive frequency the circuit goes from below to above resonance

Concept Question: Leading or Lagging?

The plot shows the driving voltage V (black curve) and the current I (red curve) in a driven RLC circuit. In this circuit,

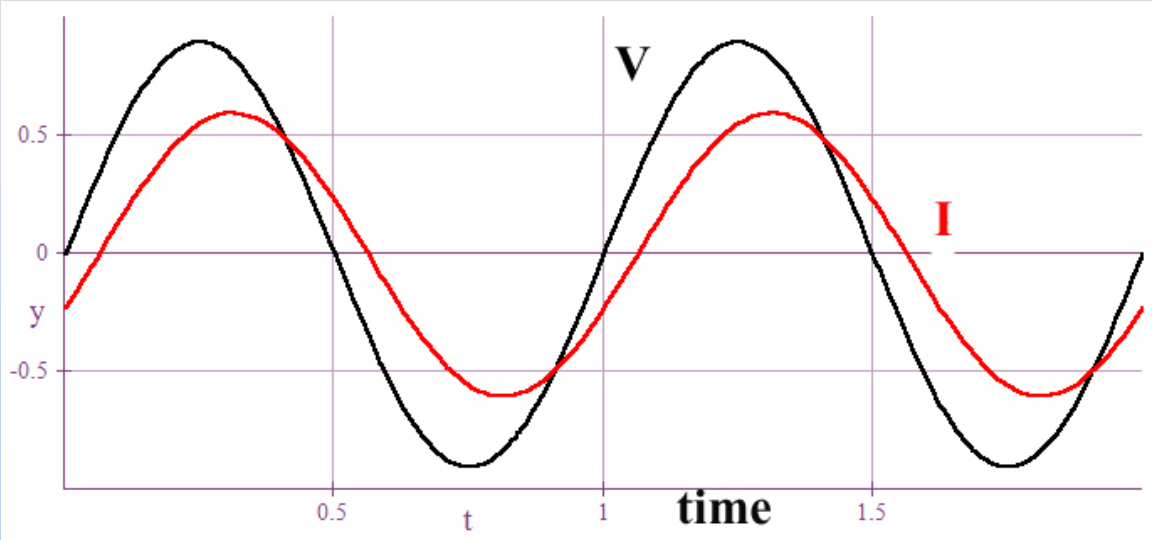


1. The current leads the voltage
2. The current lags the voltage
3. Don’t have a clue.

Concept Question Answer: Leading or Lagging?

Answer:

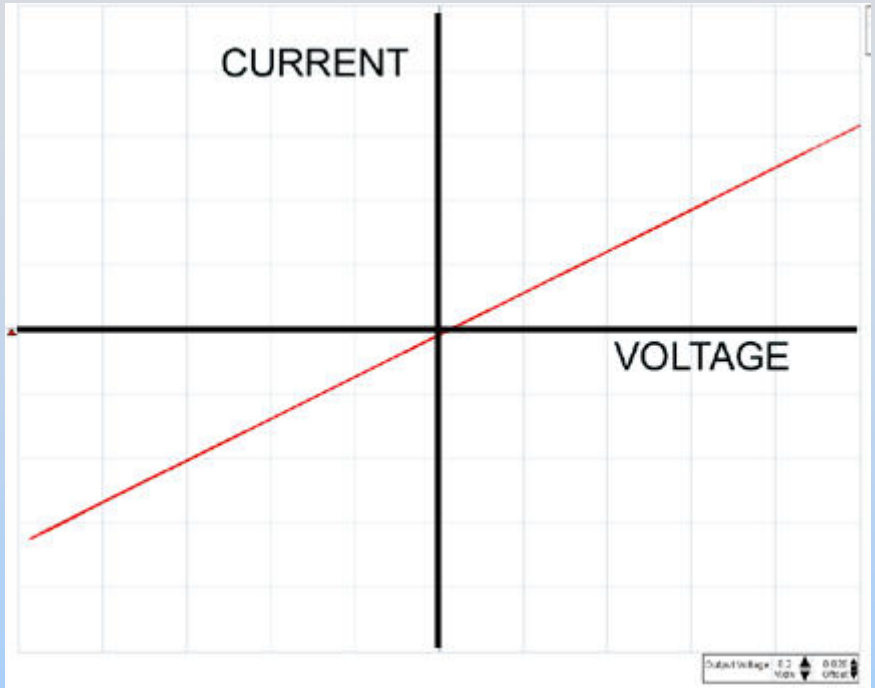
2. I lags V



The current peaks after the voltage peaks

Concept Question: Leading or Lagging?

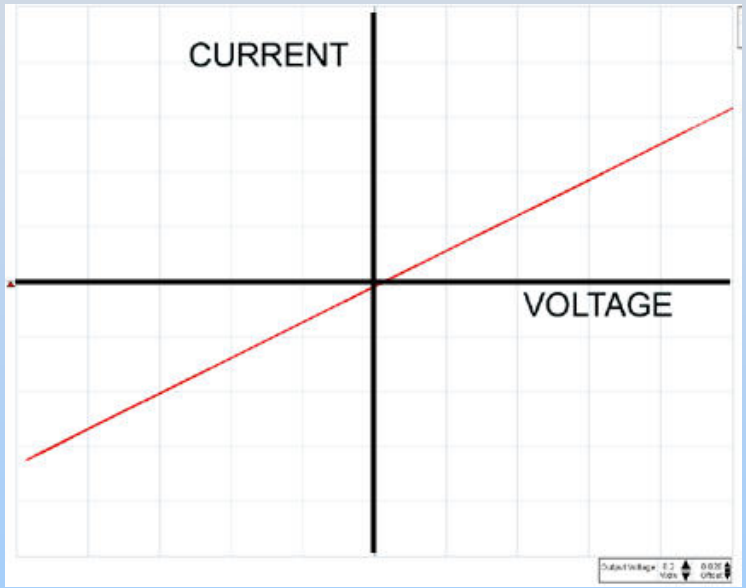
The graph shows current versus voltage in a driven RLC circuit at a given driving frequency. In this plot



1. The current leads the voltage by about 45º
2. The current lags the voltage by about 45º
3. The current and the voltage are in phase
4. Don’t have a clue

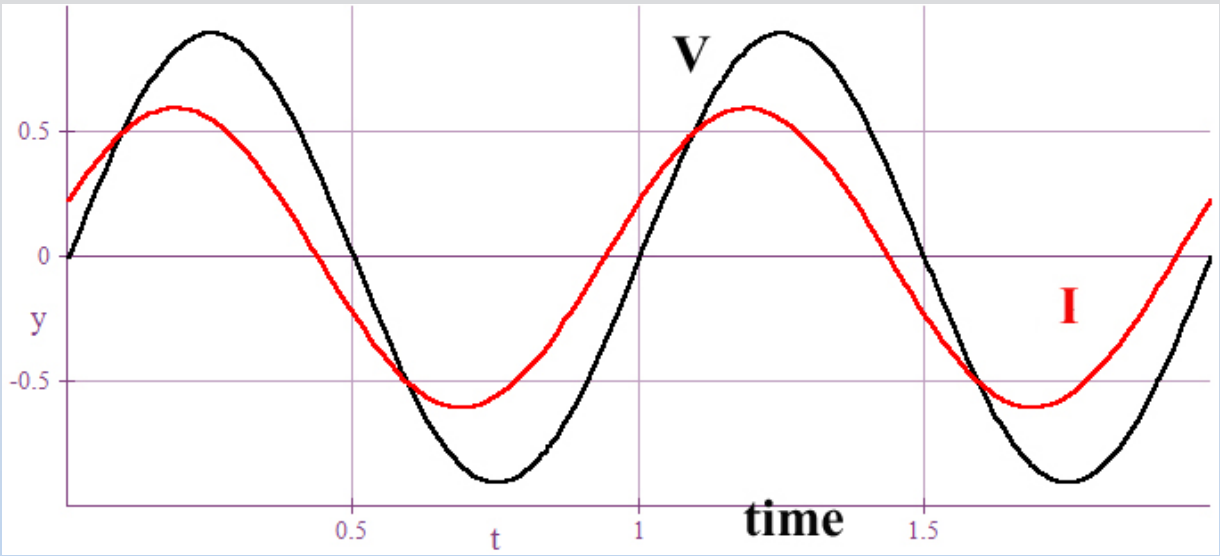
Concept Question Answer: Leading or Lagging?

Answer: 3. Current and voltage are in phase



Current and voltage reach their peaks at the same time, so they are in phase.

Concept Q.: Who Dominates?

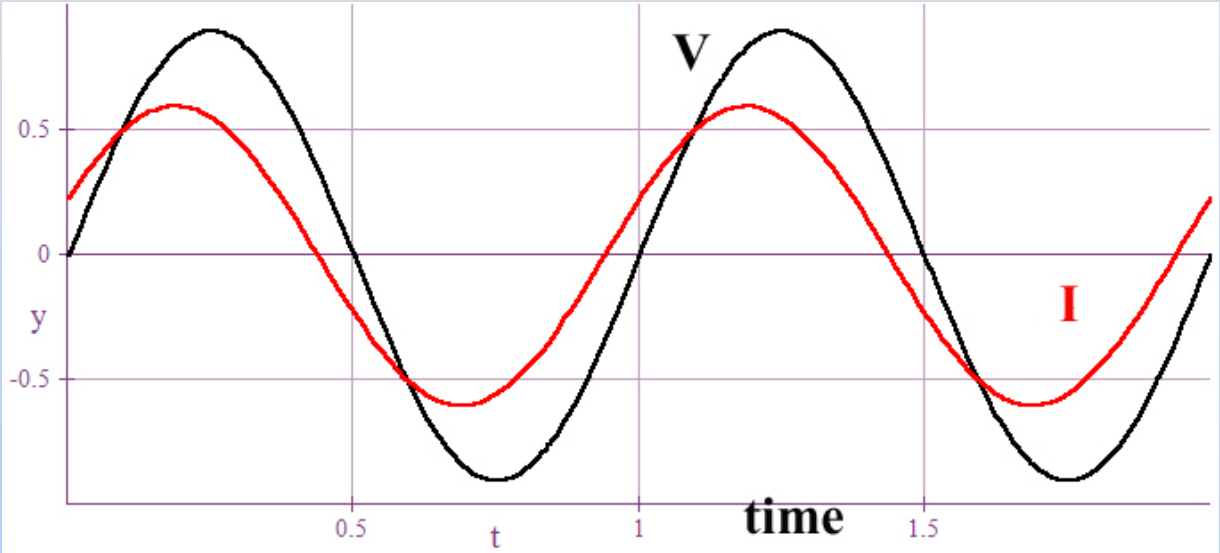


The graph shows current & voltage vs. time in a driven RLC circuit at a particular driving frequency. At this frequency, the circuit is dominated by its

1. Inductance
2. Capacitance
3. I don't know

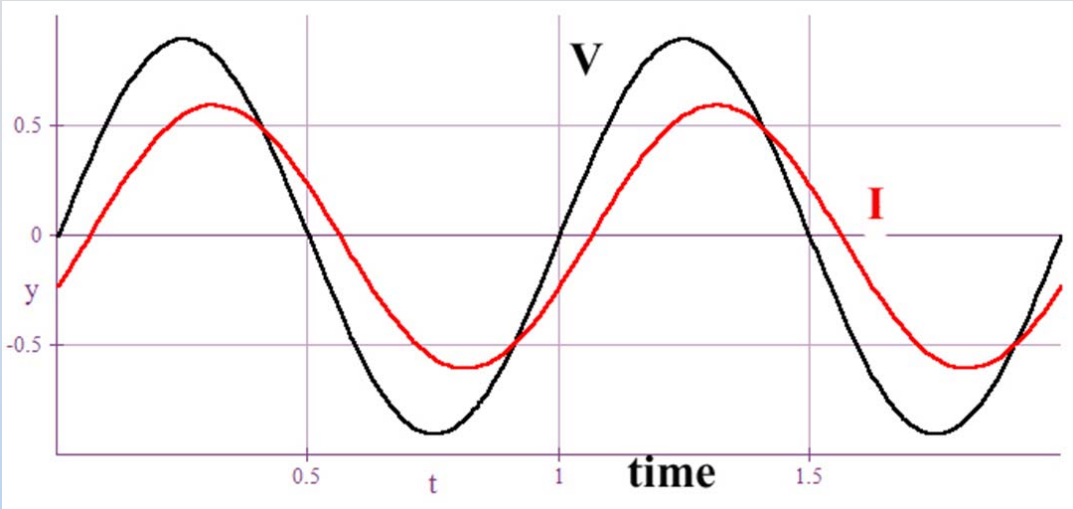
Concept Question Answer: Who Dominates?

Answer: 2. The capacitor dominates



The current leads the voltage, which is characteristic of an RLC circuit at a frequency dominated by its capacitance ($1/\omega C > \omega L$).

Concept Q.: What Frequency?

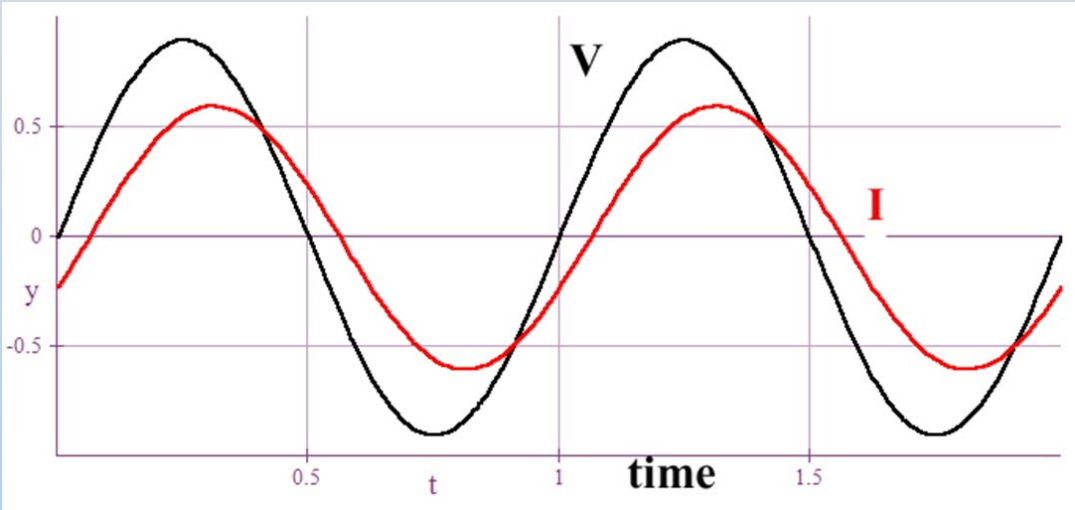


The graph shows current & voltage vs. time in a driven RLC circuit at a particular driving frequency. Is this frequency above or below the resonance frequency of the circuit?

1. Above the resonance frequency
2. Below the resonance frequency
3. I don't know

Concept Question Answer: What Frequency?

Answer: 1. Above the resonance frequency



The current lags the voltage. So $\omega L > 1/\omega C$.
Thus the frequency satisfies $\omega^2 > 1/LC$
That is, the circuit looks inductor-like, and inductors dominate at high frequencies

Concept Question: RLC Circuit With Light Bulb

Imagine another light bulb connected in parallel to this LRC circuit. With the core pulled out that light bulb would be flashing:

1. before the LRC light bulb (leading)
2. after the LRC light bulb (lagging)
3. in time with the LRC light bulb
4. not at all
5. I don't know

Concept Question Answer: RLC Light Bulb

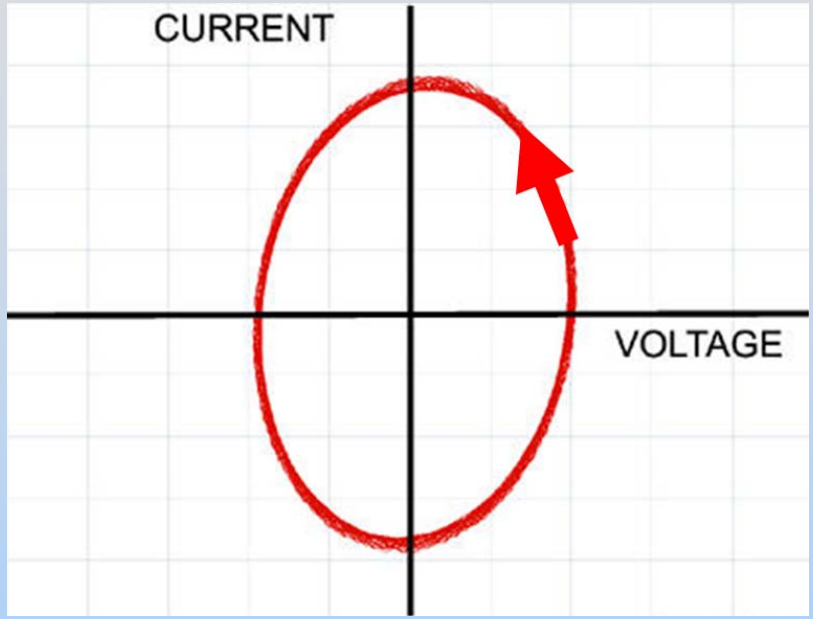
Answer:

2. The parallel light bulb lags

Taking out the core decreases the inductor's inductance and hence makes the LRC circuit more capacitor like. So the current LEADS the voltage (the battery voltage, which we are measuring with our parallel light bulb). So our parallel light bulb lags

Concept Question: Leading or Lagging?

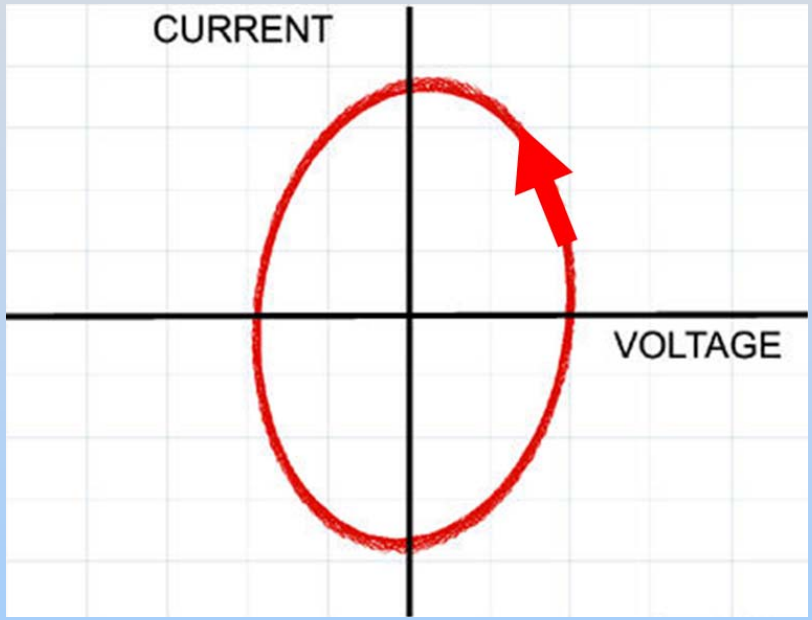
The graph shows current versus voltage in a driven RLC circuit at a given driving frequency. In this plot



1. Current lags voltage by ~90º
2. Current leads voltage by ~90º
3. Current and voltage are almost in phase
4. Not enough info (but they aren't in phase!)
5. I don't know.

Concept Question Answer: Leading or Lagging?

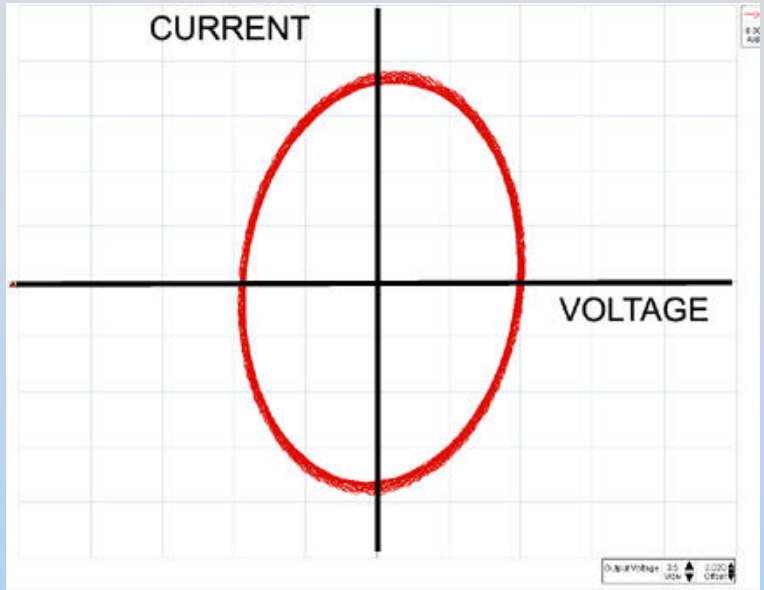
Answer: 1. Current lags voltage by ~90º



Based on the direction in which the above loop is traced out, we see that the voltage peaks first, then the current, and so forth. The current lags.

Concept Question: Leading or Lagging

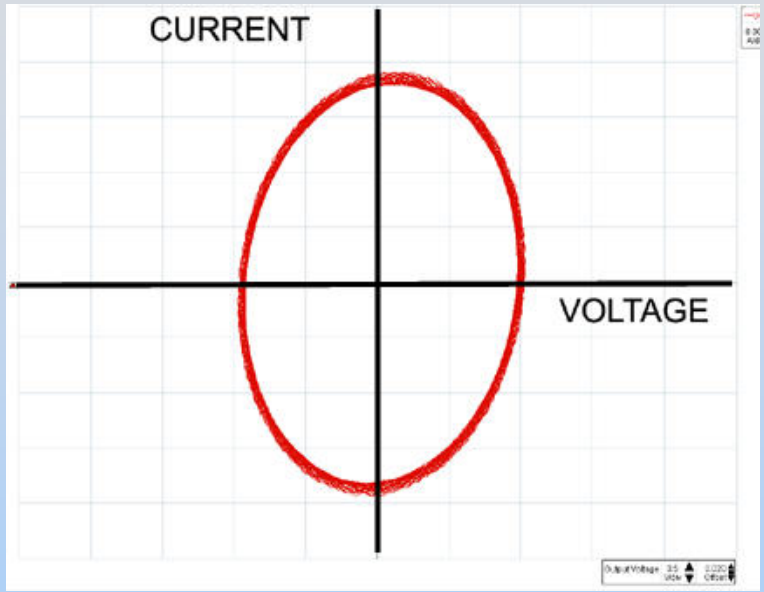
The graph shows the current versus the voltage in a driven RLC circuit at a given driving frequency. In this plot



1. Current lags voltage by ~90º
2. Current leads voltage by ~90º
3. Current and voltage are almost in phase
4. We don't have enough information (but they aren't in phase!)
5. I don't know

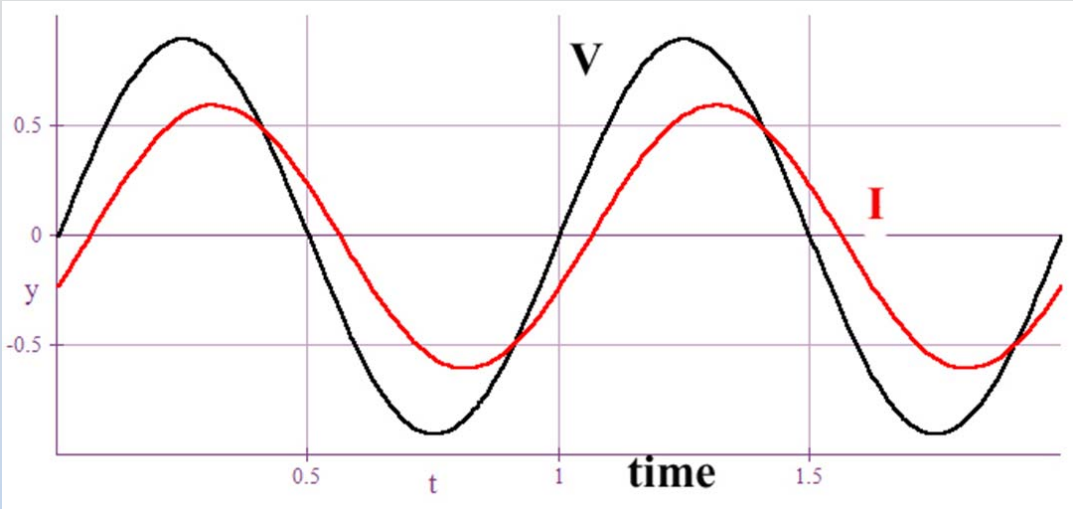
Concept Question: Answer Leading or Lagging

Answer: 4. Can't Tell



Without the direction you can't tell whether the current or voltage is leading or lagging. You can only tell that you aren't in phase (in fact, you are out of phase by ~90º)

Concept Question: What'd You Do?

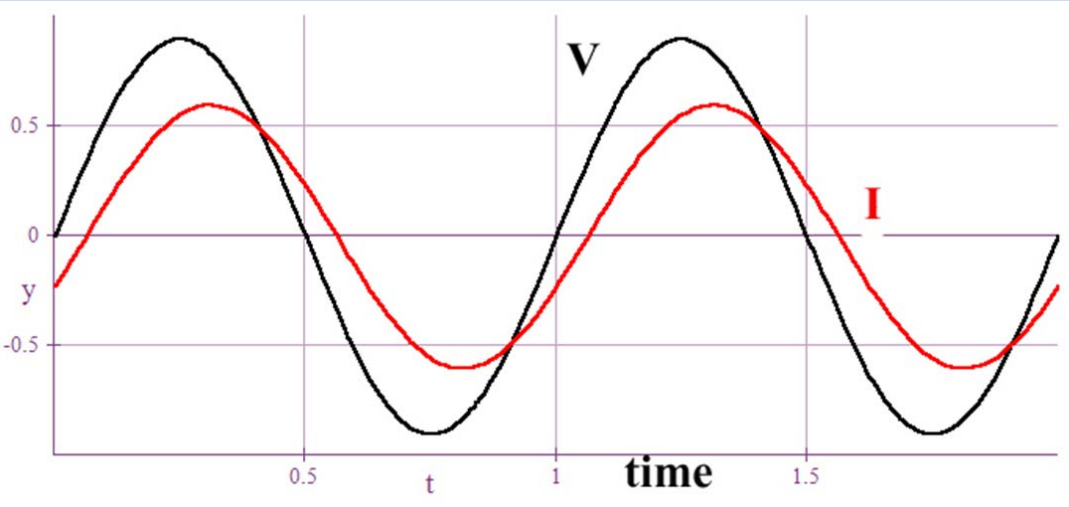


The graph shows current & voltage vs. time in a driven RLC circuit. We had been in resonance a second ago but then either put in or took out the core from the inductor. Which was it?

1. Put in the core
2. Took out the core
3. I don't know

Concept Question Answer: What'd You Do?

Answer: 1. You put in the core



The current lags the voltage which means that the circuit is inductor-like which means that we made the inductance bigger (put in the core).

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8.02SC Physics II: Electricity and Magnetism

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