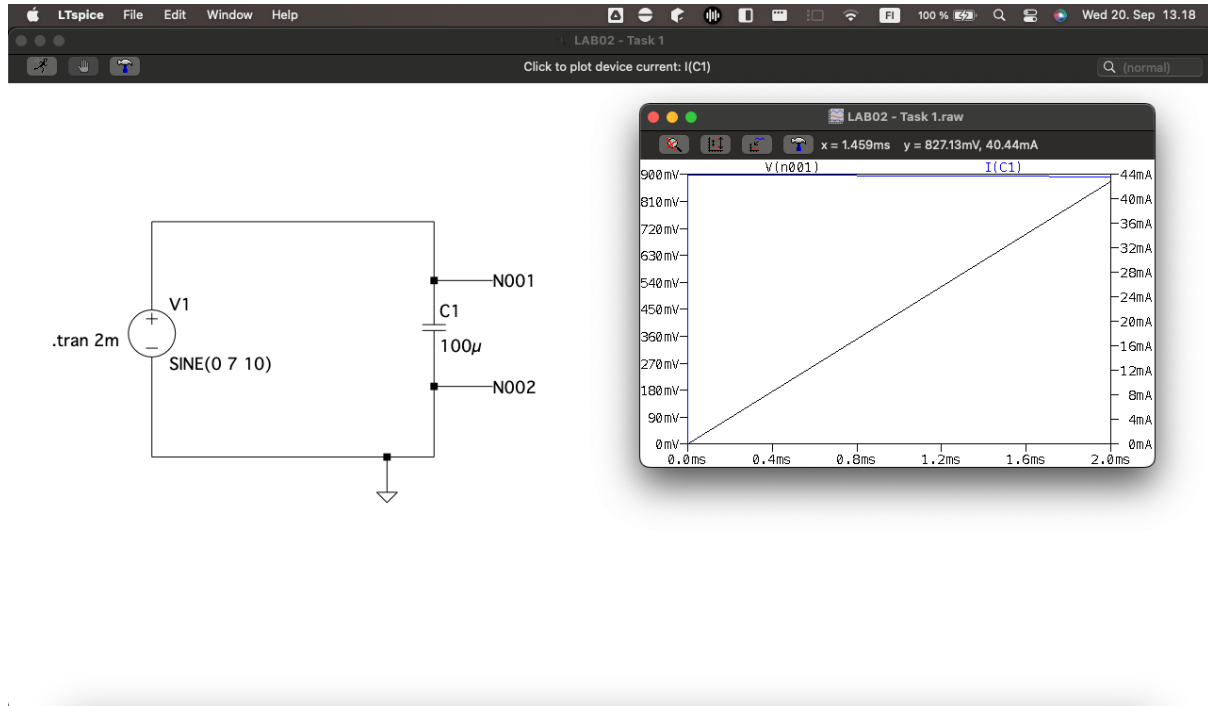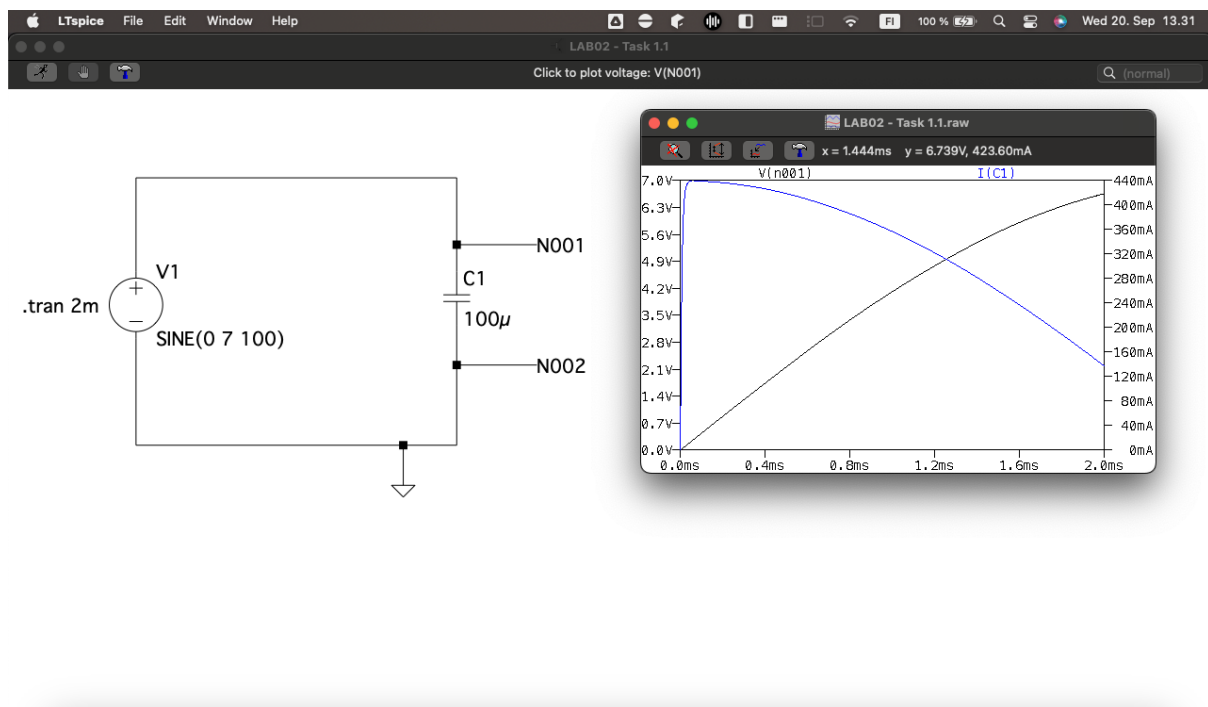# Task 1

1.1

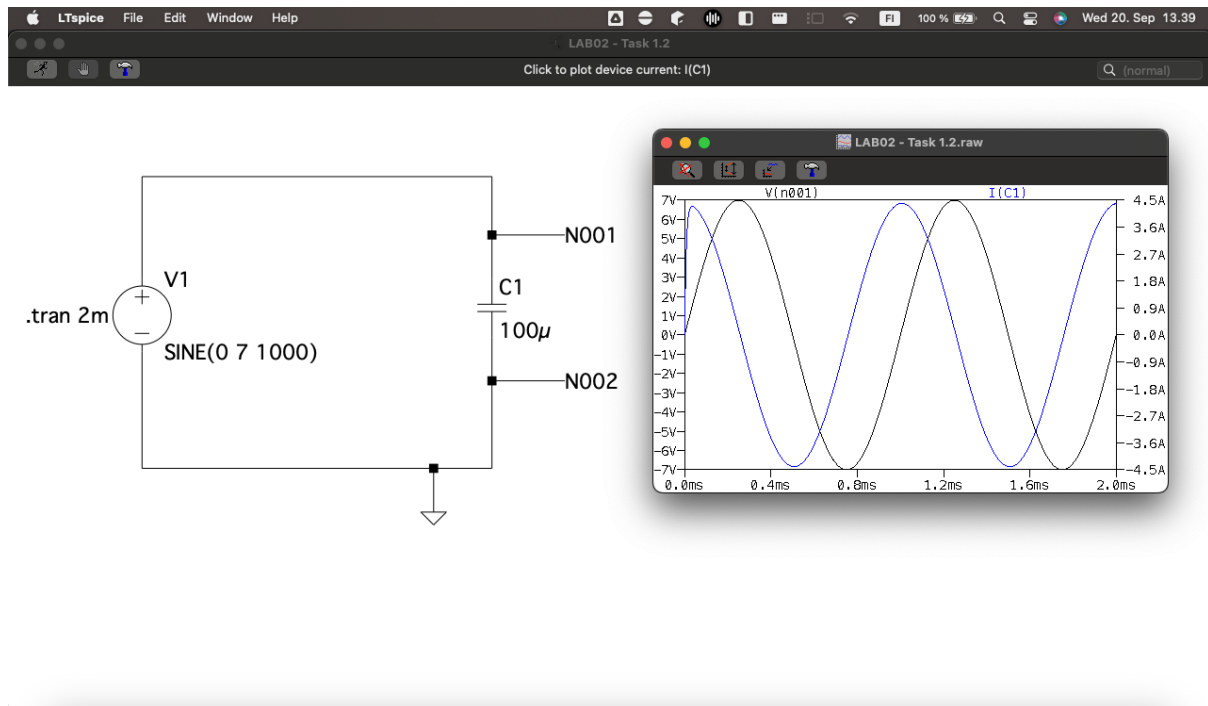Components and Variables: AC Voltage with amplitude 7 Volts at 10 Hz, 100uF capacitor.

1.2

Components and Variables: AC Voltage with amplitude 7 Volts at 100 Hz, 100uF capacitor.
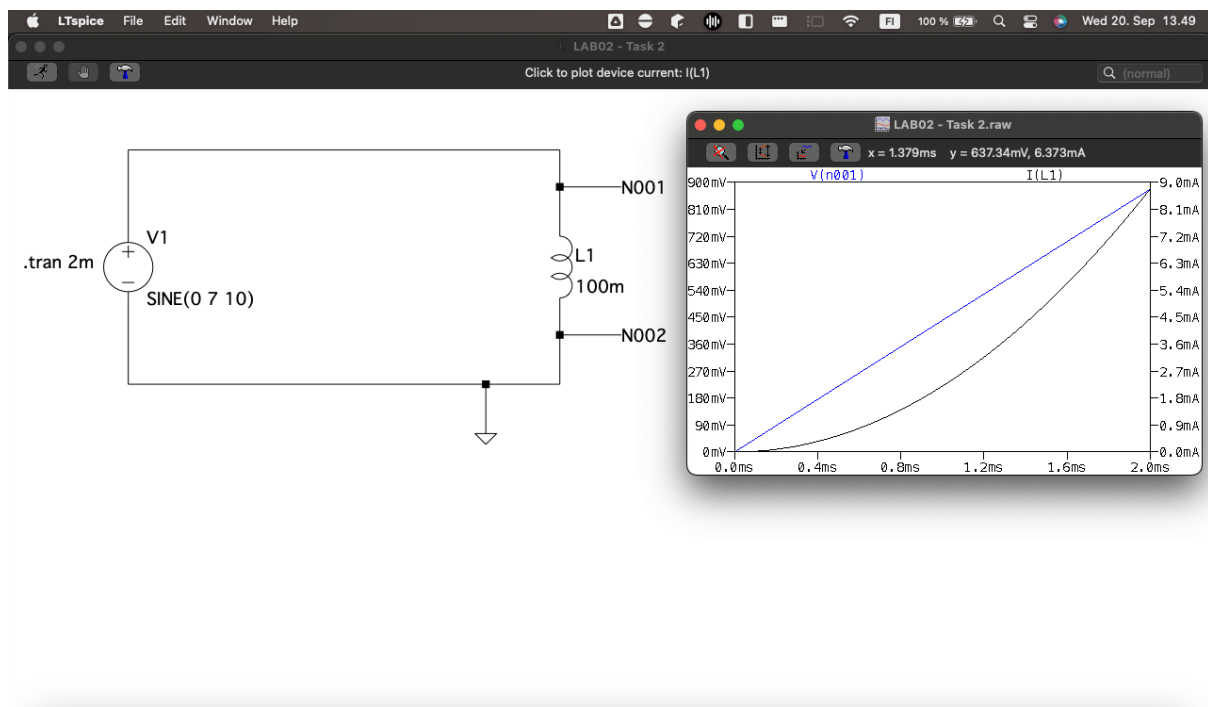
1.3

Components and Variables: AC Voltage with amplitude 7 Volts at 1000 Hz, 100uF capacitor.
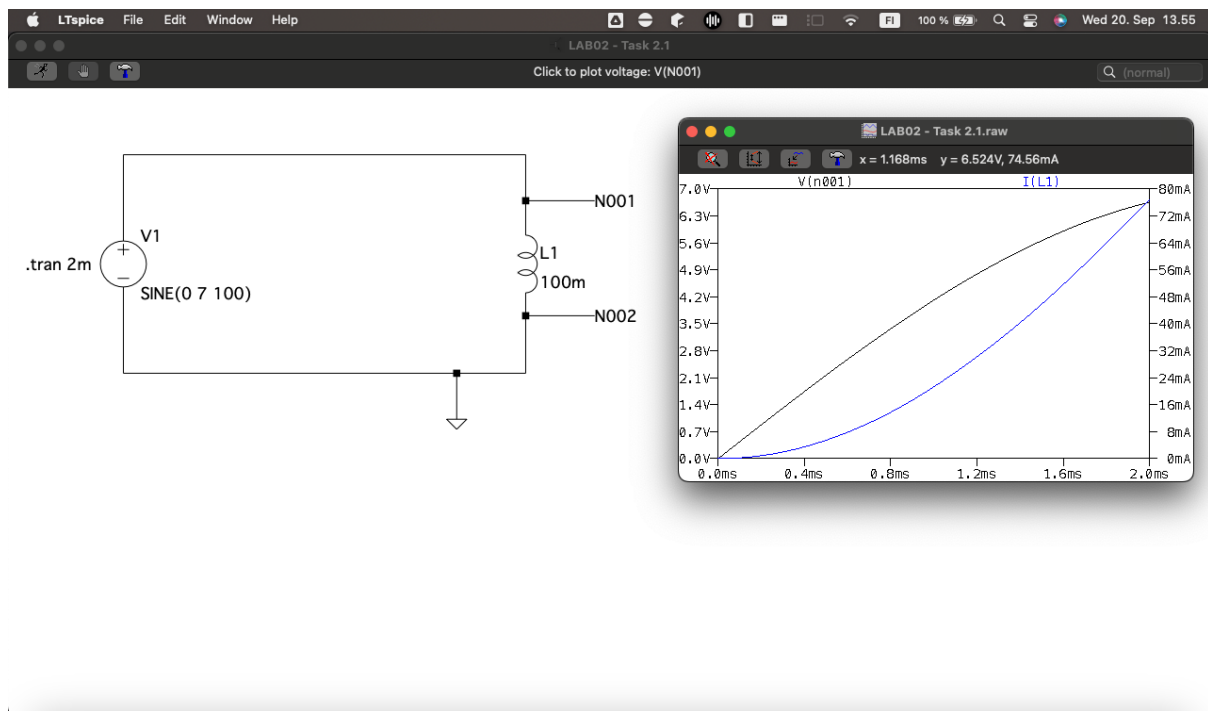

Task 2

2.1

Components and Variables: AC Voltage with amplitude 7 Volts at 10 Hz, 100mH inductor.

2.2

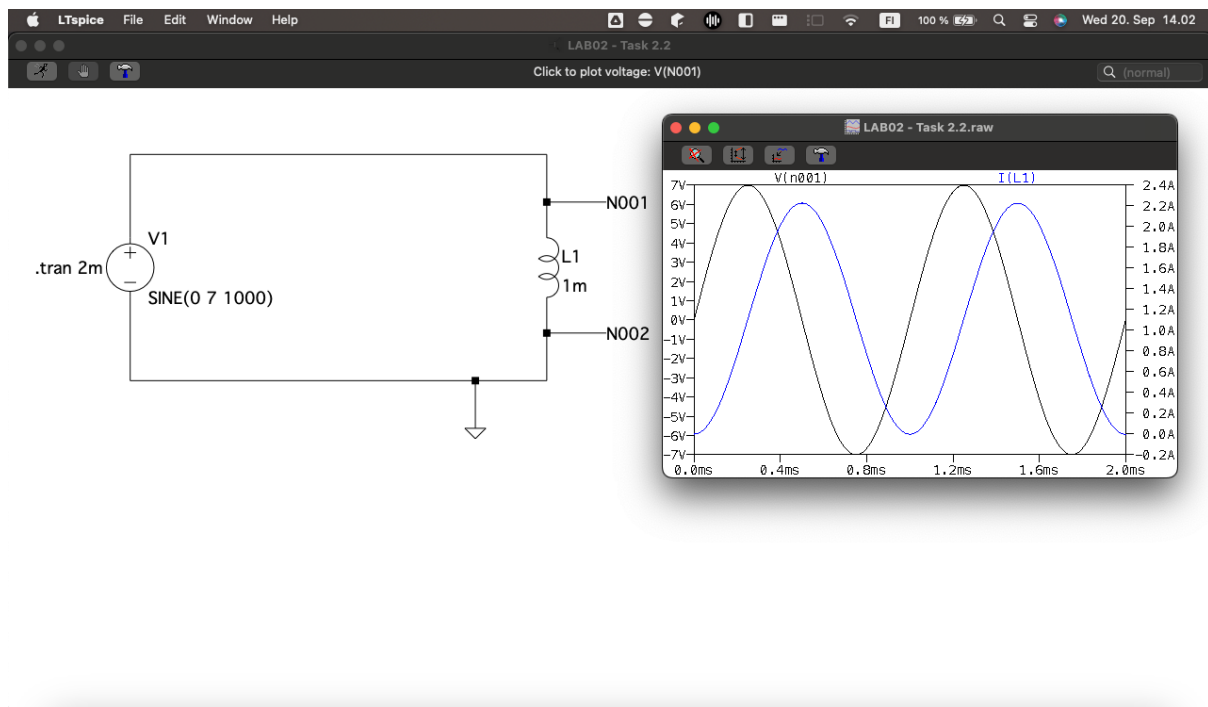Components and Variables: AC Voltage with amplitude 7 Volts at 100 Hz, 100mH inductor.
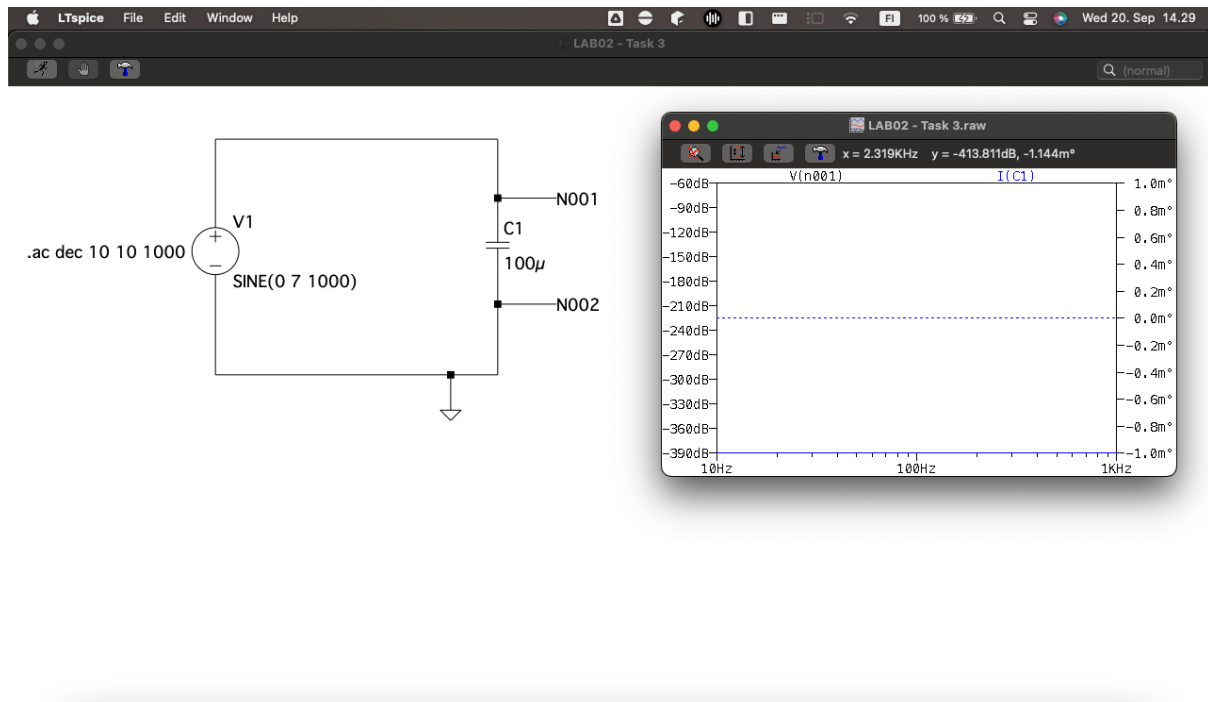

2.3

Components and Variables: AC Voltage with amplitude 7 Volts at 1000 Hz, 100mH inductor.
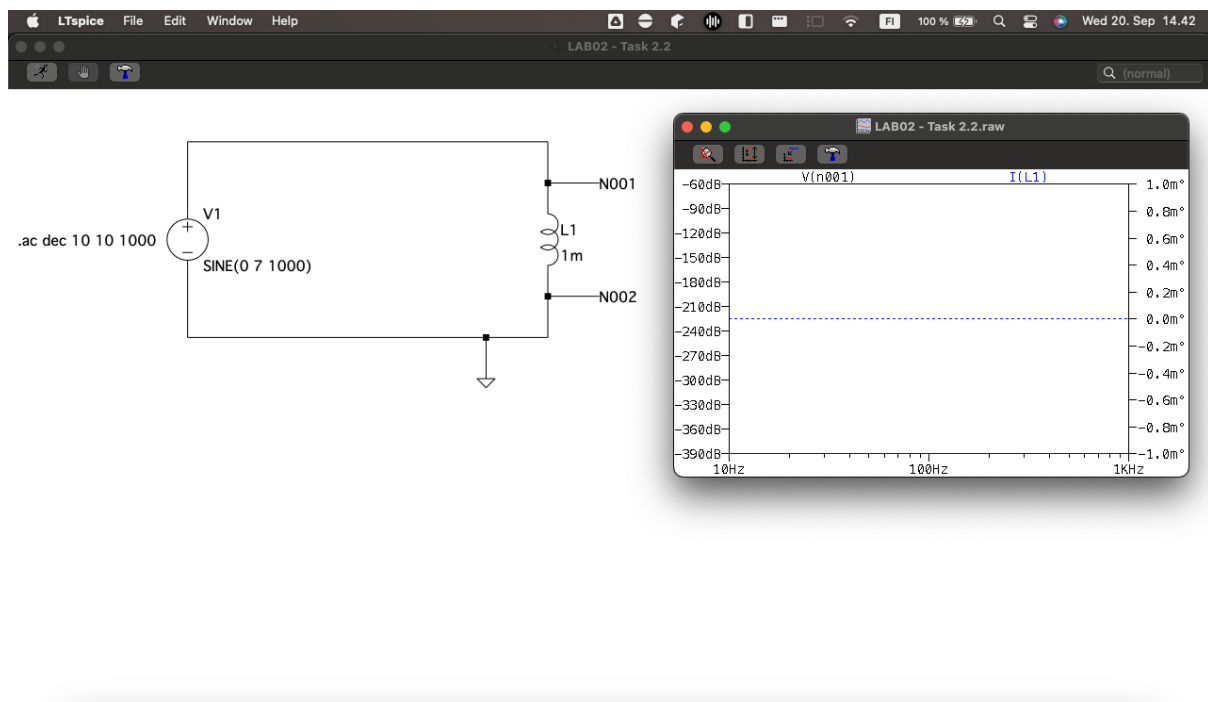
Task 3

3.1

Components and variables: AC Voltage with amplitude 7 Volts at 10 Hz, 100Hz, 1000Hz, 100uF capacitor.

3.2

Components and variables: AC Voltage with amplitude 7 Volts at 10 Hz, 100Hz, 1000Hz, 100uH inductor.

Conclusion:

Upon analyzing the two circuits, we observe the contrasting behavior of reactive components, i.e., capacitors and inductors, when subjected to AC voltages of varying frequencies.

Transient Analysis

1. Capacitor Circuit:
   - At 10Hz , the capacitor offers a high reactance, resulting in a low current flow. The voltage across the capacitor would be close to the supply voltage.
   - At 100Hz, the capacitive reactance decreases, allowing for more current to pass through the capacitor. Consequently, a potential difference can be noted across the capacitor, although it may still be close to the input.
   - At 1000Hz, the capacitor's reactance is at its lowest among the tested frequencies. This means a higher current flows through the capacitor. The voltage across the capacitor may show a phase shift compared to the source due to its reactive nature.

   Using the formula $X_c = 1/2\pi f C$, we can determine the capacitive reactance at each frequency. As the frequency increases, the capacitive reactance decreases, leading to an increase in current flow.

2. Inductor Circuit:
   - At 10Hz, the inductor has low inductive reactance, allowing higher current to flow through it. The voltage across the inductor might be minimal.
   - At 100Hz, the inductive reactance increases, resulting in a reduction of current flow through the inductor. The voltage across the inductor would increase.
   - At 1000Hz, the inductor's reactance is at its peak among the given frequencies. This results in the least amount of current passing through it. The voltage across the inductor will be significant and exhibit a phase shift compared to the source due to its reactive nature.

   Using the formula $X_L = 2\pi f L$, we can determine the inductive reactance at each frequency. As the frequency increases, the inductive reactance increases, causing a decrease in current flow.

In summary, capacitors tend to oppose changes in voltage and allow more current to flow at higher frequencies. In contrast, inductors oppose changes in current, allowing less current to flow at higher frequencies.

Once you've conducted the AC analysis using LTspice for the described circuits, you'd be presented with plots of magnitude and phase against frequency. From these plots, you can derive the following conclusions:

AC Analysis

1. Capacitor Circuit:

   - As the frequency increases, the magnitude of the current through the capacitor will rise. This observation aligns with the decreasing capacitive reactance (X_C) with increasing frequency, as described by the formula Xc = 1/2πfC

   - The phase difference between the voltage across the capacitor and the source voltage will be approximately -90 degrees, indicating that the current leads the voltage in a capacitive circuit.

   - The voltage magnitude across the capacitor will decrease with increasing frequency, especially when viewed in a log-log Bode plot representation. This is a direct consequence of the increasing current and the phase shift.

2. Inductor Circuit:

   - As the frequency increases, the magnitude of the current through the inductor will decrease. This is due to the inductor's increasing reactance (X_L) with frequency, given by the formula XL = 2πfL

   - The phase difference between the voltage across the inductor and the source voltage will be approximately +90 degrees. This indicates that the voltage leads the current in an inductive circuit.

   - The voltage magnitude across the inductor will increase with increasing frequency. This is a result of the increasing reactance and the consequent rise in voltage drop across the inductor relative to the source.

Overall Conclusion:

The AC analysis conducted for both the capacitor and the inductor circuits in LTspice reaffirms the fundamental principles of reactive components in AC circuits:

- Capacitors tend to let more current pass as frequency increases, while opposing voltage changes.

- Inductors tend to resist changes in current more aggressively as frequency rises, while allowing voltage changes.