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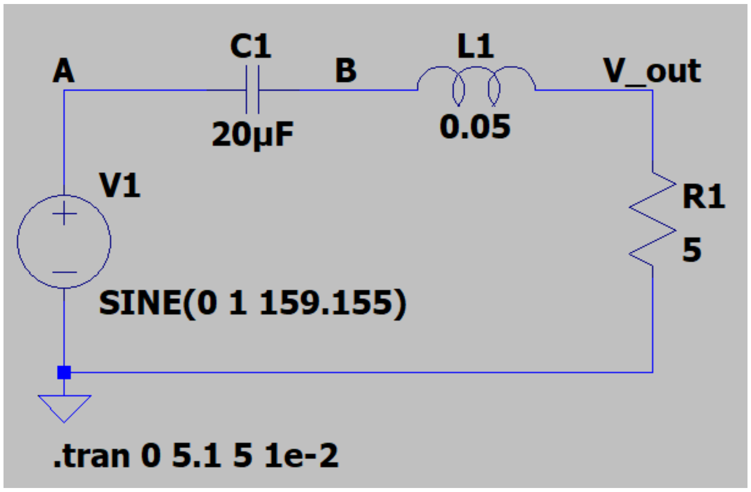
Assignment 3: Resonant Circuits and Filters

Exercise 1: RLC Series Network at Resonance

Schematic:



Netlist:
* C:\Users\gurle\Documents\LTspiceXVII\eleceng 2cf3 assignements\assignment 3\assig3_q1.asc
V1 A 0 SINE(0 1 159.155)
L1 B V_out 0.05
C1 B A 20µF
R1 V_out 0 5
.tran 0 5.1 5 1e-2
.backanno
.end

Name of File: assig3_q1.asc

Calculations:

$$L = \frac{1}{w_0^{\ 2}C} = \frac{1}{(1000^2)(0.00002)} = 0.05H$$

$$Q = \frac{w_0 L}{R} = \frac{(1000)(0.05)}{5} = 10$$

$$f_0 = \frac{w_0}{2\pi} = \frac{1000}{2\pi} = 159.15Hz$$

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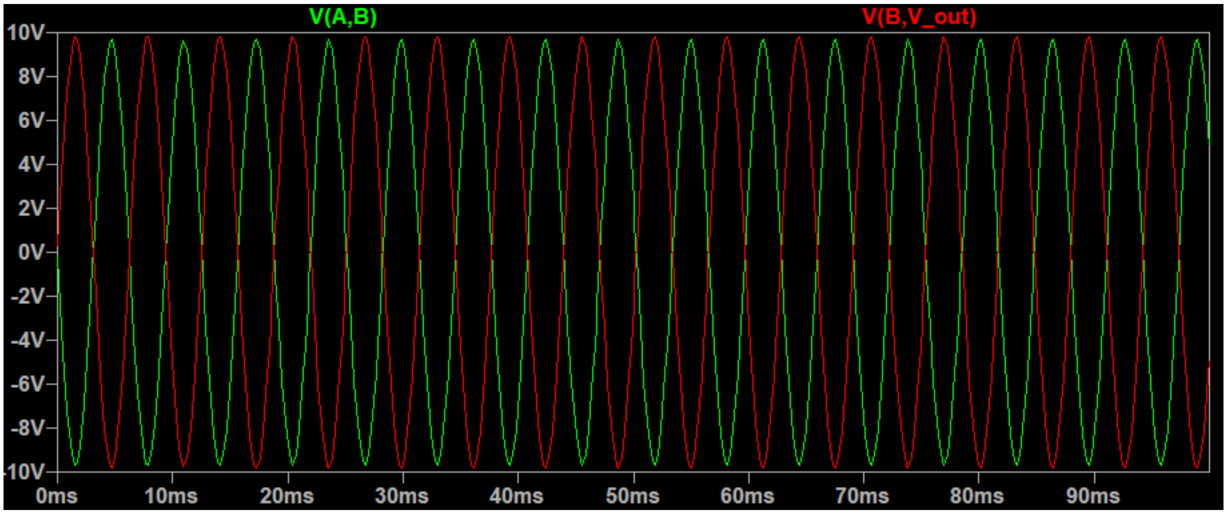
$$V_L(w_0) = Ijw_0L = (\frac{1\angle 0°}{5})(1000)(\angle 90°)(0.05) = 10\angle 90°$$

$$V_C(w_0) = \frac{1}{jw_0C} = \frac{1}{(1000)(0.00002)(\angle 90°)} = 10\angle - 90°$$

Waveforms:



Do the simulation results for v_C(t) and v_L(t) at the resonant frequency confirm the magnitude and phase calculation for the phasors v_L and v_C in part 4? Justify your answer.

The simulation results for v_C(t) and v_L(t) are confirmed by the calculations for the phasors v_L and v_C. Both of the magnitudes were 10V. Both v_L and v_C each have a phase shift of 90° in opposite directions which can also be seen on the simulation results for v_C(t) and v_L(t).

Exercise 2: RLC Series Network as a Bandpass Filter

Schematic:

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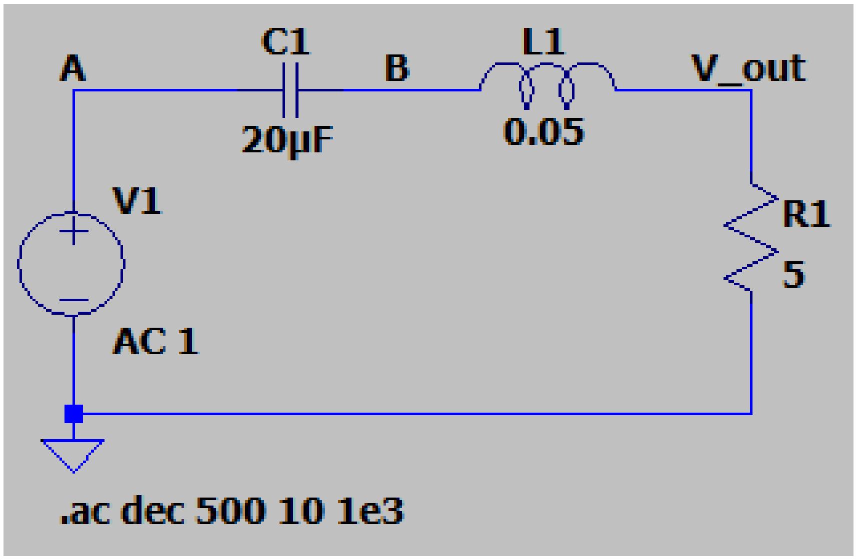

Netlist:

```
* C:\Users\gurle\Documents\LTspiceXVII\eleceng 2cf3 assignements\assignment 3\assig3_q2.asc
V1 A 0 AC 1
L1 B V_out 0.05
C1 B A 20µF
R1 V_out 0 5
.ac dec 500 10 1e3
.backanno
.end
```

Name of File: assig3_q2.asc

Calculations:

$$f_{LO} = f_0\left(\frac{-1}{2Q} + \sqrt{\left(\frac{1}{2Q}\right)^2 + 1}\right) = 151.396Hz$$

$$f_{HI} = f_0\left(\frac{1}{2Q} + \sqrt{\left(\frac{1}{2Q}\right)^2 + 1}\right) = 167.3115Hz$$

Plot:

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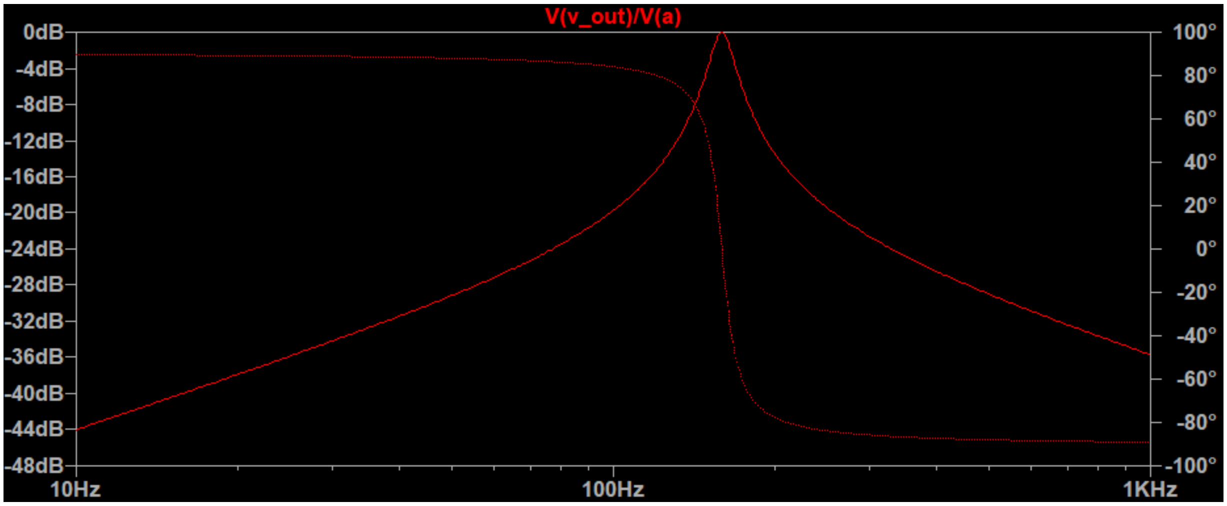

Does the magnitude-dB plot of G_v versus frequency confirm your calculations for BW, f_LO, and f_HI? The magnitude-dB plot of G_v vs frequency displays very similar results to my calculations for BW, f_LO, and f_HI. These estimates were obtained by hovering over the graph to read the values.
What are the values of the phase of G_v at the resonant frequency f_0 as well as the cut-off frequencies f_LO and f_HI, according to the simulation plot? What are these values according to theory? Is there an agreement? According to the simulation plot, the values of the phase G_v at f_0 was about 0°, at f_LO was about 44°, and at f_HI was about -44°. These values are very close to the absolute value of 45°, which shows that there is an agreement.

Exercise 3: Low-Pass Filter

Schematic:

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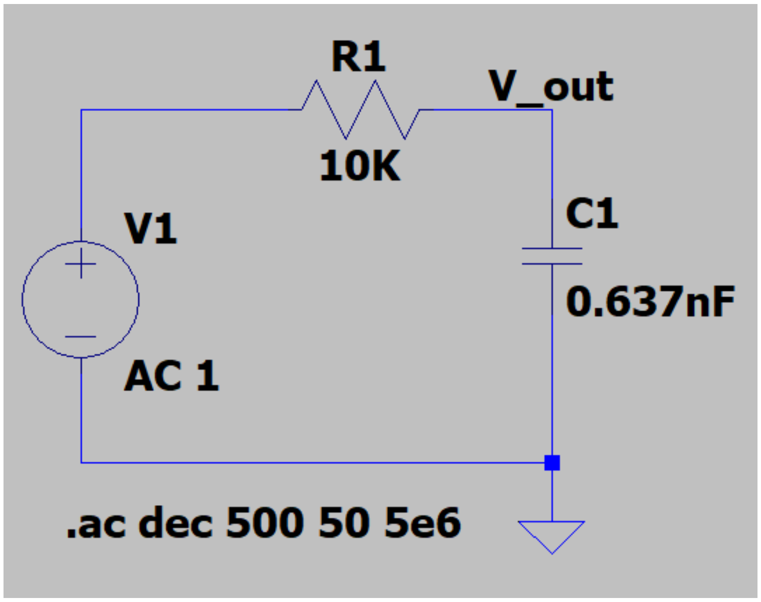

Netlist:

```
* C:\Users\gurle\Documents\LTspiceXVII\eleceng 2cf3 assignements\assignment 3\assig3_q3.asc
V1 N001 0 AC 1
R1 V_out N001 10K
C1 V_out 0 0.637nF
.ac dec 500 50 5e6
.backanno
.end
```

Name of File: assig3_q3.asc

Values of R and C:

$R = 10k$

$C = \frac{1}{2\pi R f_0} = \frac{1}{2\pi(10k)(25kHz)} = 0.637nF$

Plot:

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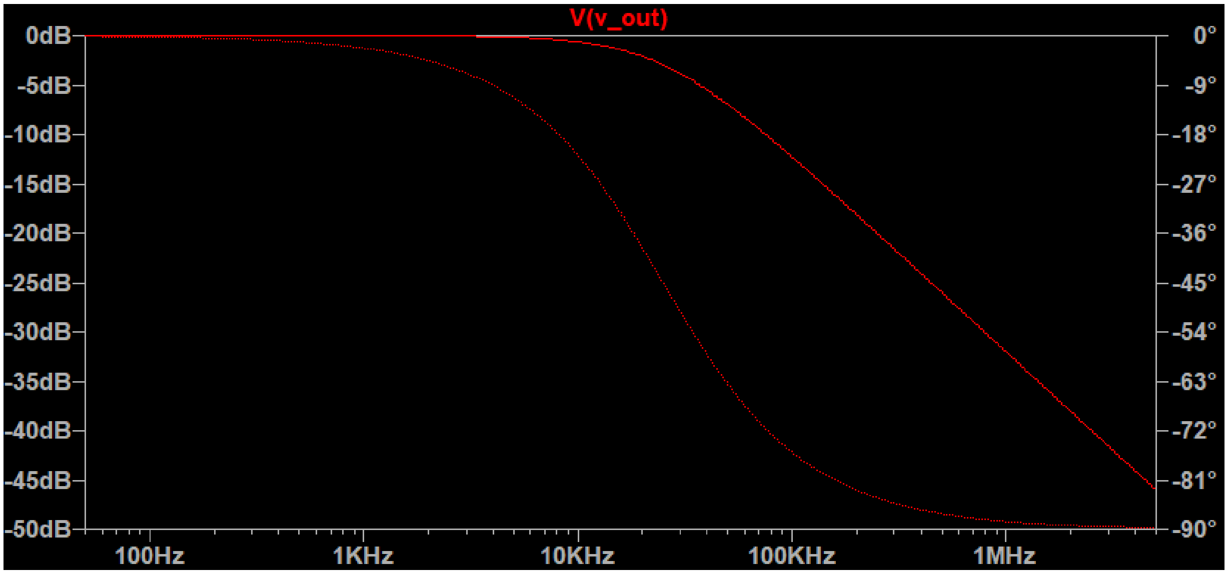
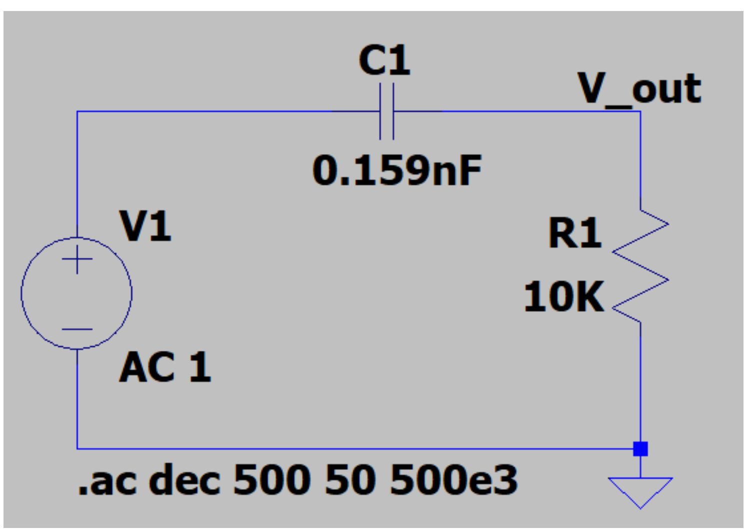


From the magnitude-dB plot of the transfer function, determine the cut-off frequency. Is it in agreement with the required value of 25 kHz?
The cut-off frequency from the magnitude-dB plot of the transfer function is about 25kHz, which is in agreement with the 25kHz.

Exercise 4: High-Pass Filter

Schematic:



Netlist:
* C:\Users\gurle\Documents\LTspiceXVII\eleceng 2cf3 assignements\assignment

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```
3\assig3_q4.asc
V1 N001 0 AC 1
R1 0 V_out 10K
C1 V_out N001 0.159nF
.ac dec 500 50 500e3
.backanno
.end
```

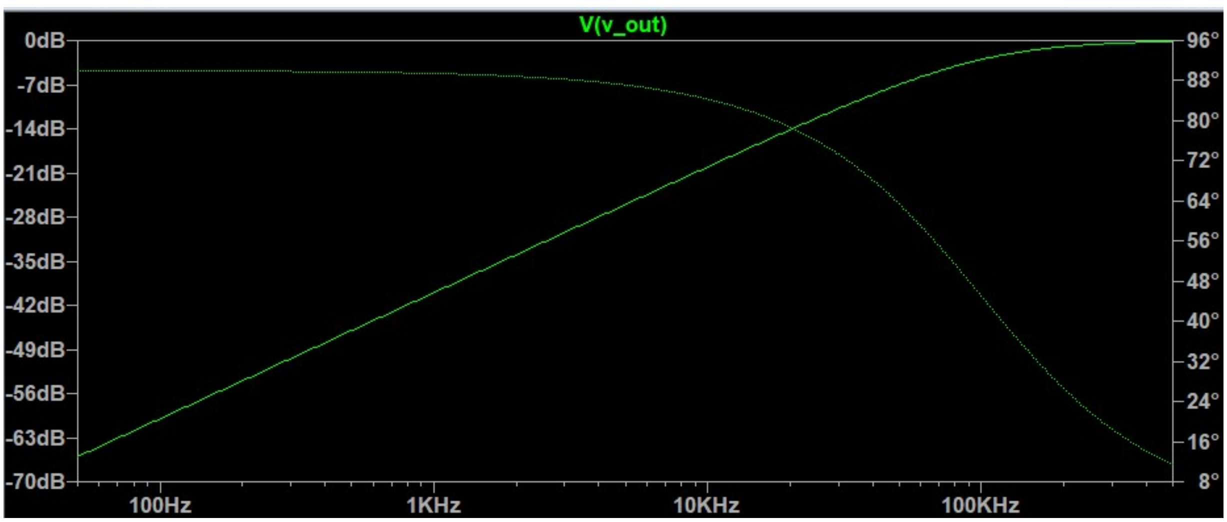
Name of File: assig3_q4.asc

Values of R and C:

$R = 10k$

$C = \frac{1}{2\pi R f_0} = \frac{1}{2\pi(10k)(100kHz)} = 0.159nF$

Plot:



From the magnitude-dB plot of the transfer function, determine the cut-off frequency. Is it in agreement with the required value of 100 kHz?

The cut-off frequency from the magnitude-dB plot of the transfer function is about 100kHz, which is in agreement with the 100kHz.