**EE2315: Industrial Electronics Laboratory**

## Experiment 7: Filters

INTENDED LEARNING OUTCOMES:

1. Be able to analyse and examine the characteristics of filters using capacitors and inductors using a circuit simulator.
2. Be able to determine the cutoff frequencies and roll off rate of low pass, high pass, and band pass filters.

PRE-LAB DISCUSSION:

A filter is a circuit which allows a certain range/s of frequencies to pass while inhibiting the passage of a certain range/s of frequencies. Filters can be classified as analog filters and digital filters. Analog filters are constructed using linear circuit techniques while digital filters are constructed using numeric data as the input signal and works in the digital domain.

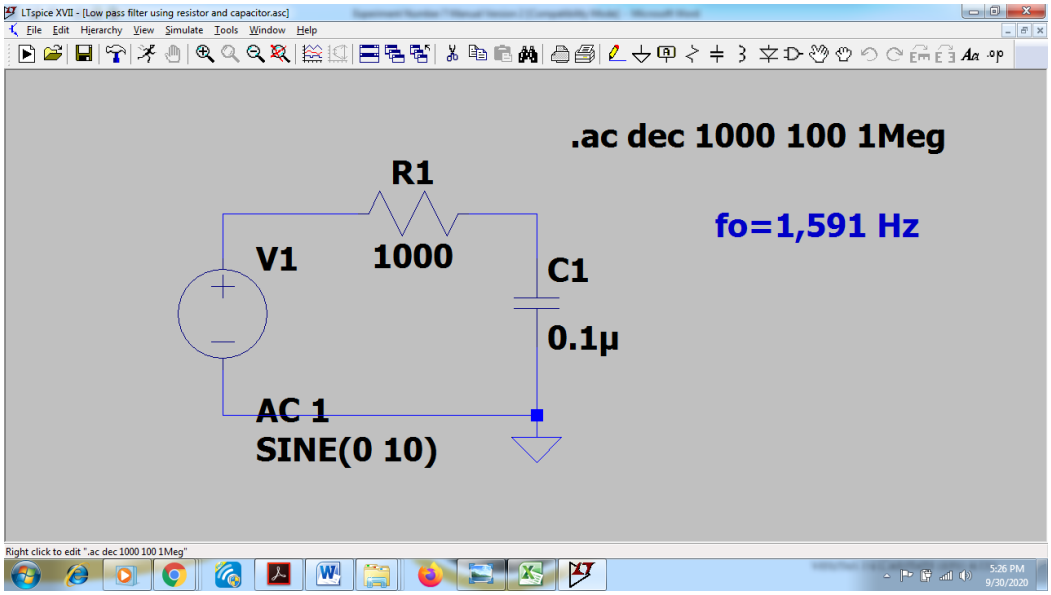
Analog filters can be classified as passive filters and active filters. Passive filters typically use a combination of passive elements such as resistors, capacitors and inductors. The output voltage of passive filters is typically lower than its input voltage. Passive filters have "insertion losses" (Output Power / Input Power < 1). Active filters typically use a combination of resistors, capacitors, inductors, and an active or amplification device such as BJTs, FETS, and op amps. The output voltage of active filters can be made smaller, the same, or higher than its input voltage depending on the requirements. This can be considered as an advantage of active filters compared to passive filters. Op amps are commonly used in active filters because of the many advantages it offers.

Filters can be classified as low pass, high pass, band pass, and band-reject (notch type) filter. A low pass filter allows frequencies below a certain cutoff frequency to pass. A high pass filter allows frequencies above a certain cutoff frequency to pass. A band pass filter allows frequencies above a certain low cutoff frequency and below a certain high cutoff frequency to pass. A band-reject or band stop filter allows frequencies above a certain cutoff frequency to pass, and frequencies below a certain cutoff frequency to pass.

The roll-off rate of a filter is the rate of change of the response of the filter in the transition band. The roll-off rate is determined by its order. The higher is a filter's order, the faster is its roll-off rate. Higher order filters are used to make the transition band narrower. The order of a filter also determines the minimum number of reactive components needed for the filter. As an example, a second order filter will need at least two reactive components, such as two capacitors, or a capacitor and an inductor. For many general-purpose low and high pass filters, the order of the filter indicates the number of poles. This is not true for more complex filters.

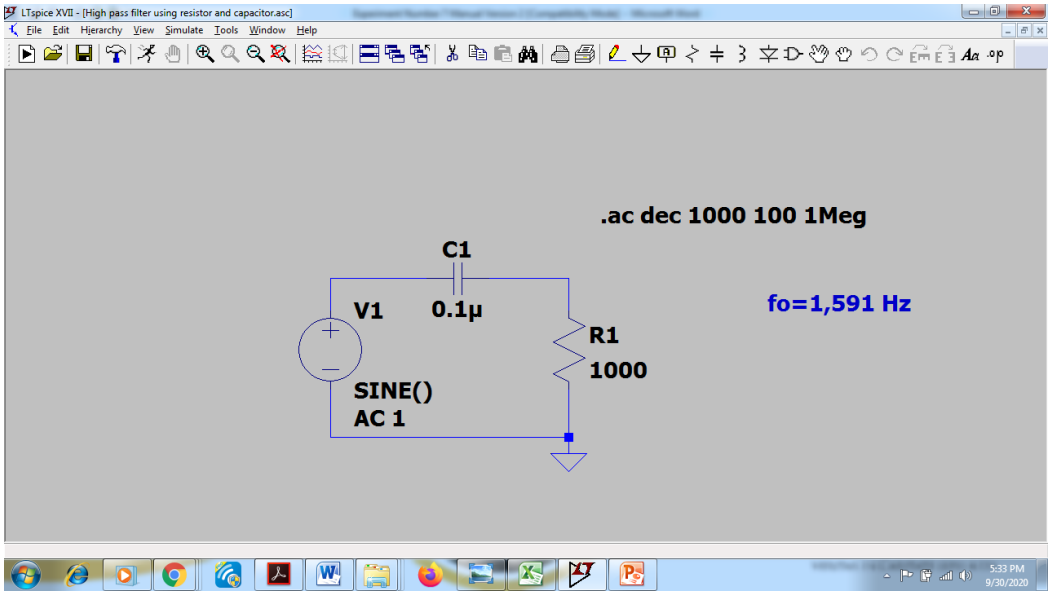
PROCEDURE:

1. Construct the low pass filter using resistor and capacitor shown below.



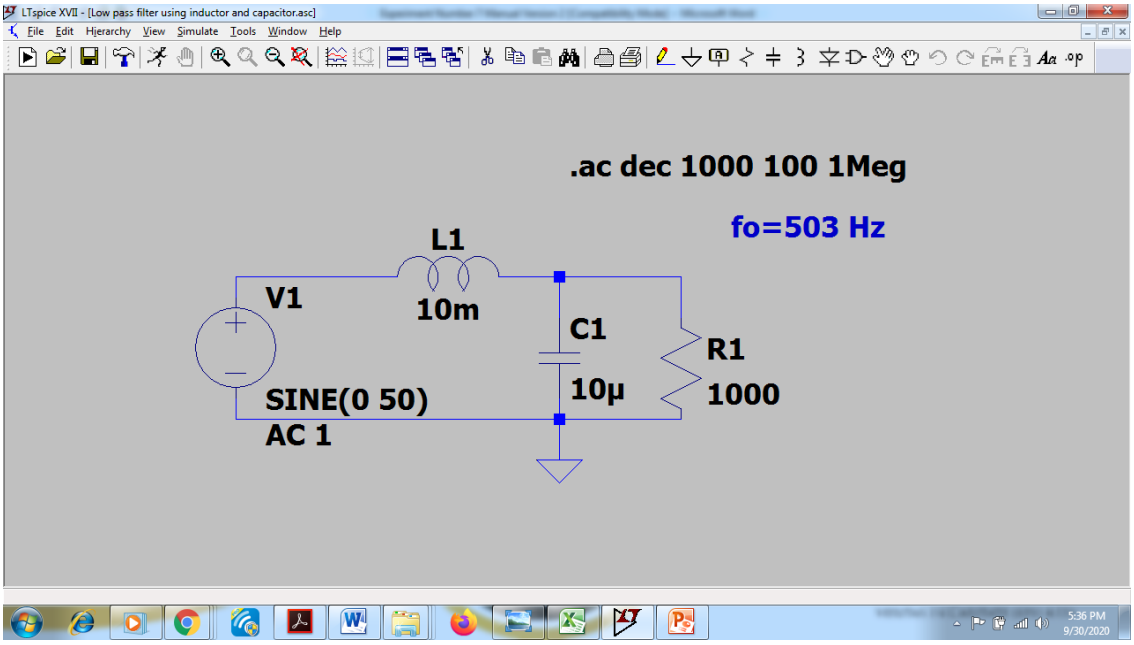

2. Run simulation using LTspice and determine the cutoff or corner frequency using the cursor on LTspice and record it on Table 1.
3. Compute for the cutoff or corner frequency and record it on Table 1.
4. Determine the roll off rate of the transition band using the 2 cursors of LTspice and record it on Table 1. Paste a picture of the Bode plot on Table 1.

5. Construct the high pass filter using resistor and capacitor shown on the figure below.



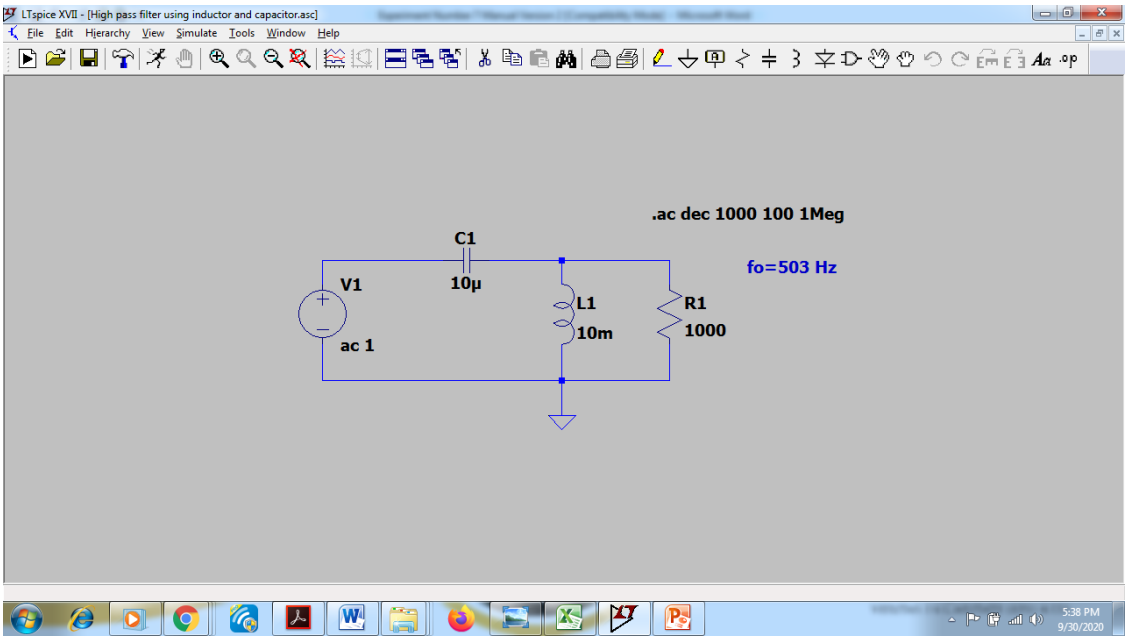
6. Repeat steps 2 to 4 for the high pass filter using resistor and capacitor but use Table 2 instead of Table 1.

7. Construct the low pass filter circuit using inductor and capacitor shown below.



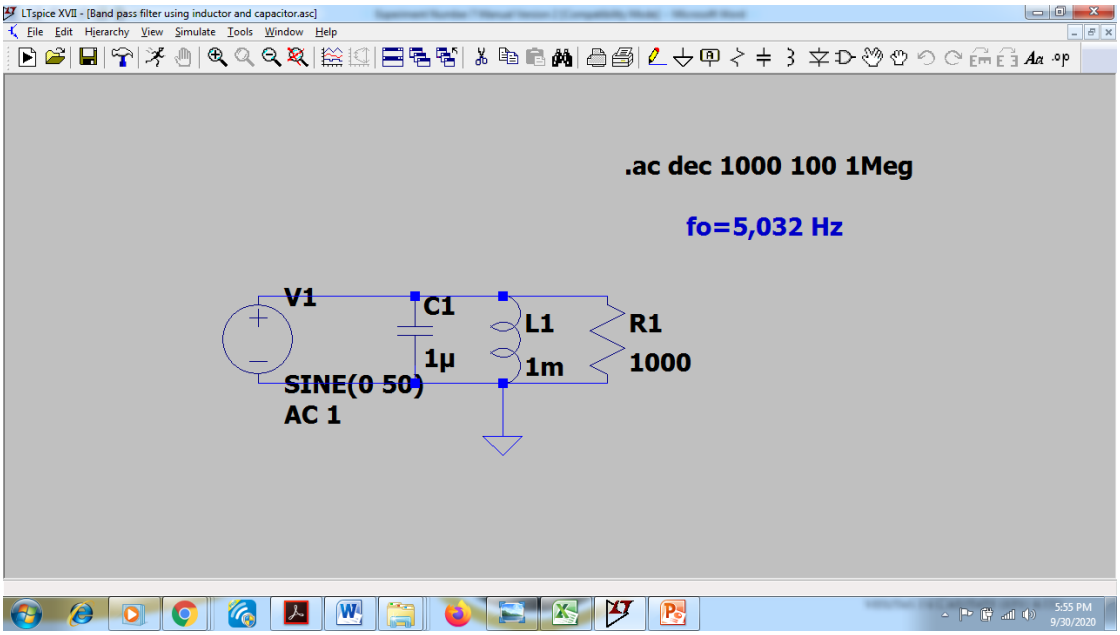

8. Repeat steps 2 to 4 for the low pass filter using inductor and capacitor but use Table 3 instead of Table 1.

9. Construct the high pass filter circuit using inductor and capacitor shown below.



10. Repeat steps 2 to 4 for the high pass filter using inductor and capacitor but used Table 4 instead of Table 1.

11. Construct the band pass filter circuit using inductor and capacitor shown below.




12. Include a 5 ohm internal resistance for the sine wave voltage source. Determine the resonant frequency and cutoff frequencies using the cursors of LTspice and put it on Table 5. Paste a copy of the Bode plot on Table 5.

**Experiment 7: Filters Group Report**

Group No.: _____
Group Members: _____
_____
_____

Table 1

| | |
|---|---|
| Cutoff frequency using LTspice | |
| Computed cutoff frequency | |
| Roll off rate using LTspice | |
| Bode plot | |

Table 2

| | |
|---|---|
| Cutoff frequency using LTspice | |
| Computed cutoff frequency | |
| Roll off rate using LTspice | |
| Bode plot | |

Table 3

| | |
|---|---|
| Cutoff frequency using LTspice | |
| Computed cutoff frequency | |
| Roll off rate using LTspice | |
| Bode plot | |

Table 4

| | |
|---|---|
| Cutoff frequency using LTspice | |
| Computed cutoff frequency | |
| Roll off rate using LTspice | |
| Bode plot | |

Table 5

| | |
|---|---|
| Low corner frequency using LTspice | |
| High corner frequency using LTspice | |
| Resonant frequency | |
| Roll off rate using LTspice (Lower Transition Band) | |
| Roll off rate using LTspice (Upper Transition Band) | |
| Bode plot | |

Conclusion:

<Inset Conclusion Here>