LIC INNOVATIVE PROJECT

AIM
To simulate all 4 types of Filter circuits using the PSpice software and plot their frequency responses.

SOFTWARE USED

OrCAD EE PSpice is a SPICE circuit simulator application for simulation and verification of analog and mixed-signal circuits. PSpice is an acronym for Personal Simulation Program with Integrated Circuit Emphasis.

THEORY

In signal processing, a filter is a device or process that removes some unwanted components or features from a signal. Filtering is a class of signal processing, the defining feature of filters being the complete or partial suppression of some aspect of the signal. Most often, this means removing some frequencies or frequency bands.

However, filters do not exclusively act in the frequency domain; especially in the field of image processing many other targets for filtering exist. Correlations can be removed for certain frequency components and not for others without having to act in the frequency domain. Filters are widely used in electronics and telecommunication, in radio, television, audio recording, radar, control systems, music synthesis, image processing, and computer graphics.

Filters are often described in terms of a number of parameters including type, order, and response. There are four filter types: Lowpass Highpass Bandpass Bandreject

1) Lowpass
2) Highpass
3) Bandpass
4) Bandreject

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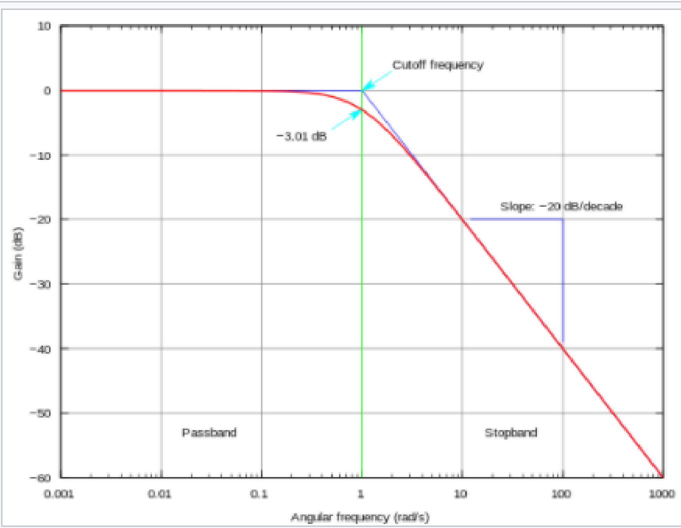
The order of the filter usually determines the amount of attenuation the filter provides–the higher the order, the more the attenuation. There are a number of filtering responses available. The most commonly used are Butterworth, Chebyshev, and Bessel. Each response has its advantages and disadvantages.

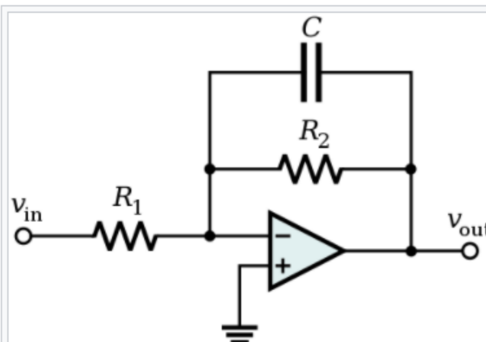
1) Low-Pass Filter

A low-pass filter (LPF) is a filter that passes signals with a frequency lower than a selected cutoff frequency and attenuates signals with frequencies higher than the cutoff frequency. The exact frequency response of the filter depends on the filter design. The filter is sometimes called a high-cut filter, or treble-cut filter in audio applications. A low-pass filter is the complement of a high-pass filter.

Low-pass filters exist in many different forms, including electronic circuits such as a hiss filter used in audio, anti-aliasing filters for conditioning signals prior to analog-to-digital conversion, digital filters for smoothing sets of data, acoustic barriers, blurring of images, etc.



The gain-magnitude frequency response of a first-order (one-pole) low-pass filter. *Power gain* is shown in decibels (i.e., a 3 dB decline reflects an additional half-power attenuation). Angular frequency is shown on a logarithmic scale in units of radians per second.



An active low-pass filter

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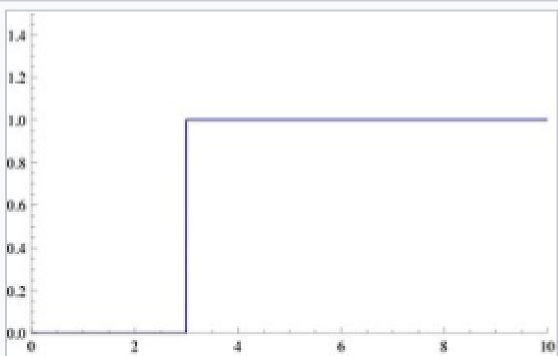
2) High-Pass Filter

A high-pass filter (HPF) is an electronic filter that passes signals with a frequency higher than a certain cutoff frequency and attenuates signals with frequencies lower than the cutoff frequency. The amount of attenuation for each frequency depends on the filter design. A high-pass filter is usually modeled as a linear time-invariant system. It is sometimes called a low-cut filter or bass-cut filter in the context of audio engineering.

High-pass filters have many uses, such as blocking DC from circuitry sensitive to non-zero average voltages or radio frequency devices. They can also be used in conjunction with a low-pass filter to produce a bandpass filter.


High-pass filter frequency response

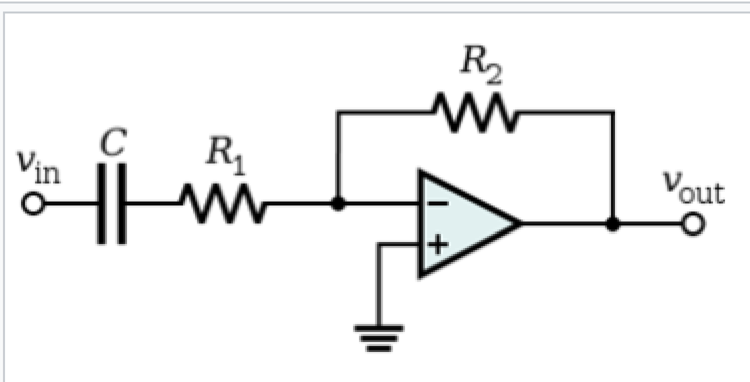


Figure 2: An active high-pass filter

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3) Band-Pass Filter

A band-pass filter or bandpass filter (BPF) is a device that passes frequencies within a certain range and rejects (attenuates) frequencies outside that range. A band-pass filter can be characterized by its Q factor. The Q-factor is the reciprocal of the fractional bandwidth. A high-Q filter will have a narrow passband and a low-Q filter will have a wide passband. These are respectively referred to as narrow-band and wide-band filters.

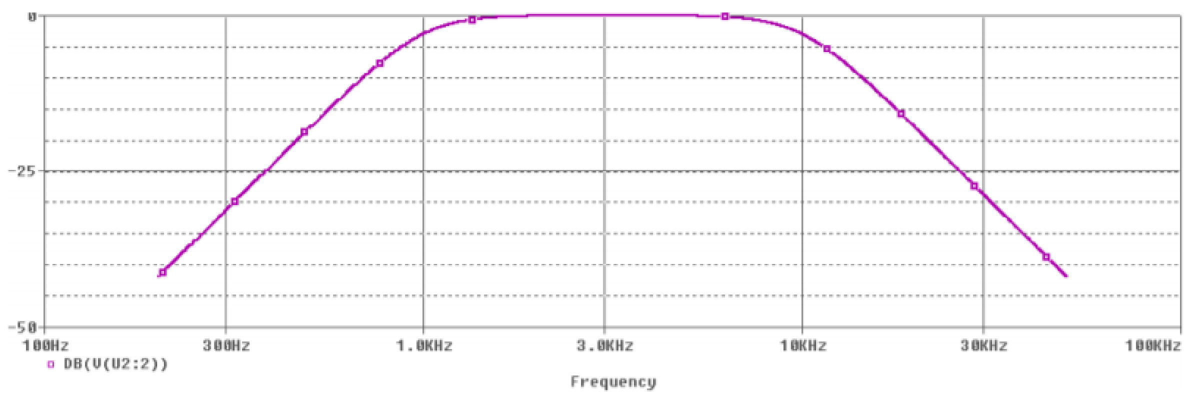
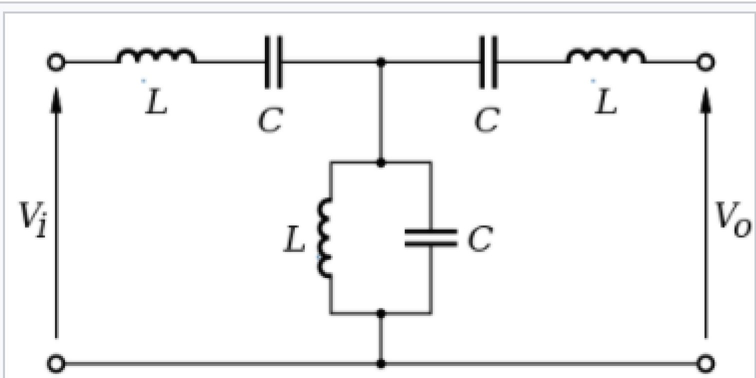


Figure 8: Frequency response of the Butterworth bandpass filter model



A medium-complexity example of a band-pass filter.

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4) Band-Reject Filter

In signal processing, a band-stop filter or band-rejection filter is a filter that passes most frequencies unaltered, but attenuates those in a specific range to very low levels. It is the opposite of a band-pass filter. A notch filter is a band-stop filter with a narrow stopband (high Q factor).

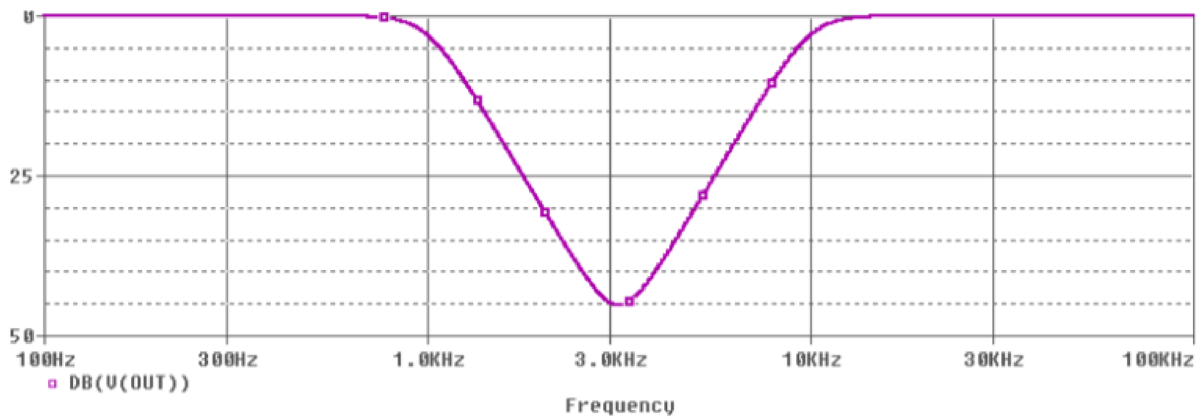

Figure 10: Frequency Response of the Band Reject Filter Circuit

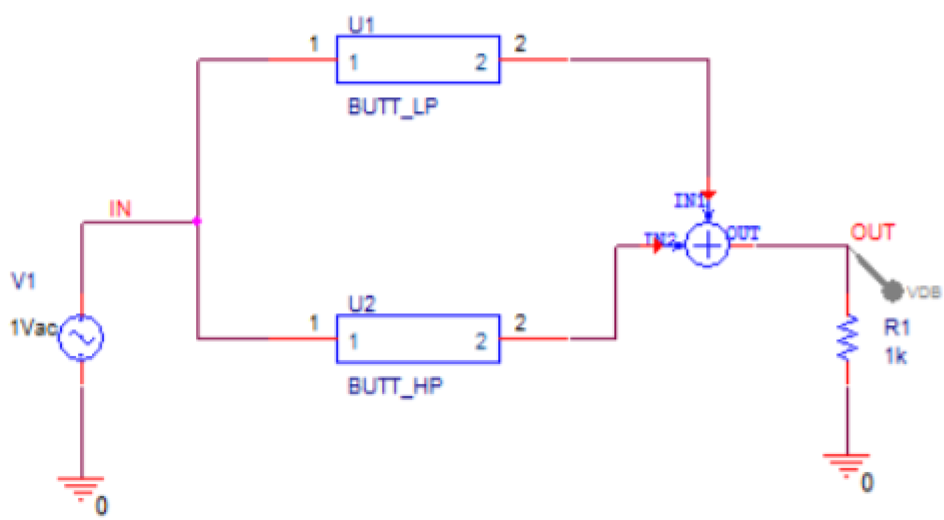

Figure 9: Band Reject Filter Circuit

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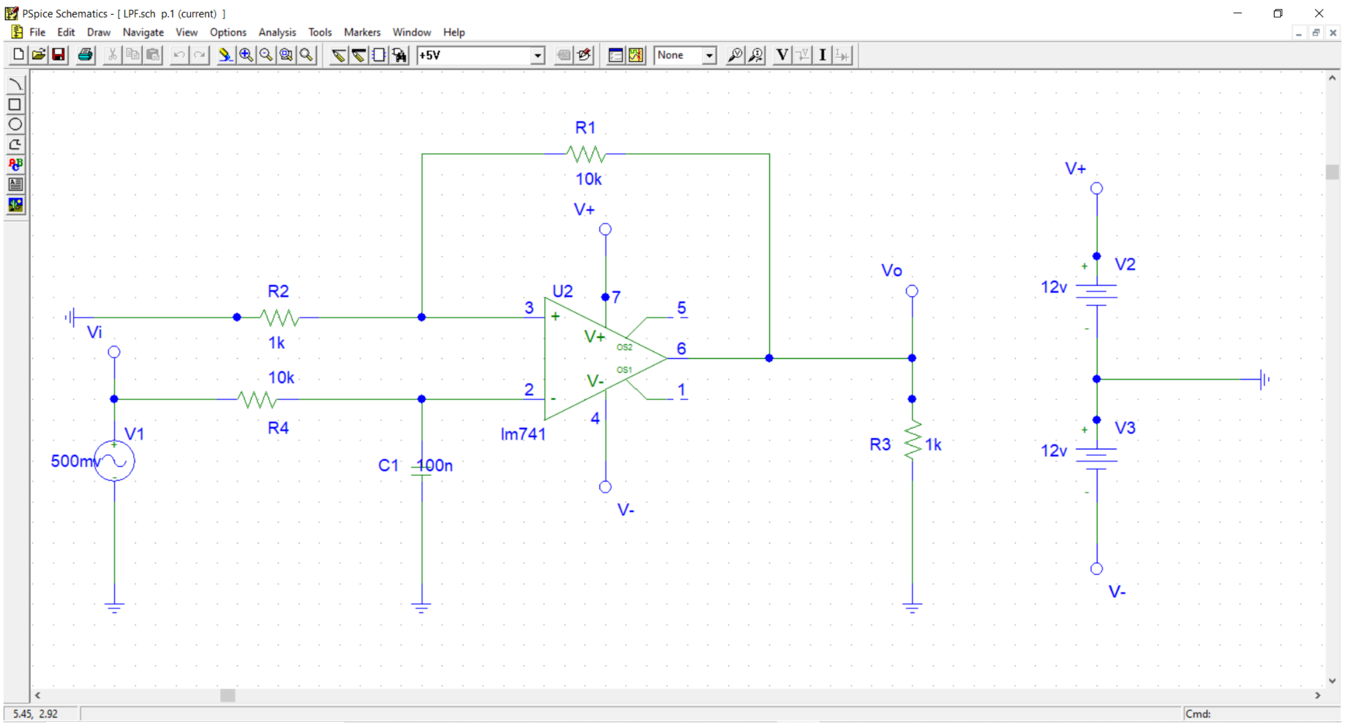
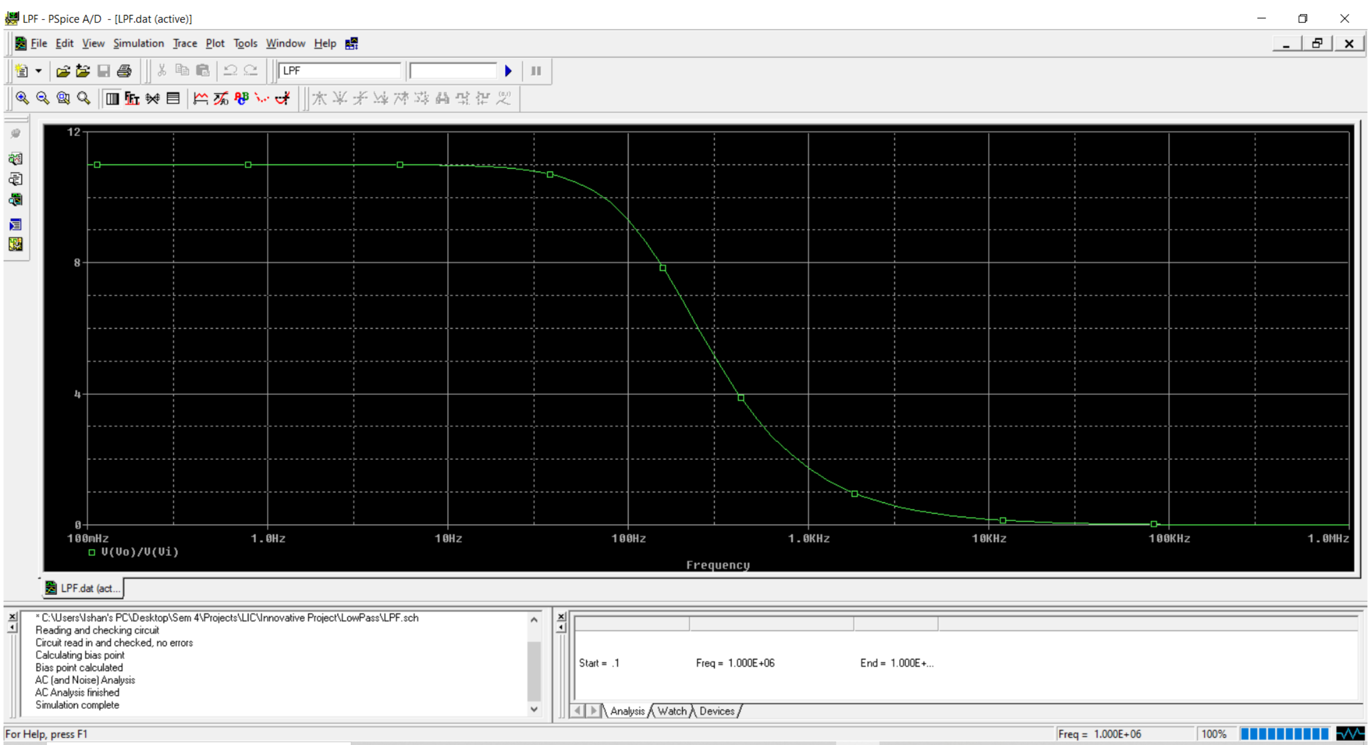
OBSERVATIONS

1) Low-Pass Filter





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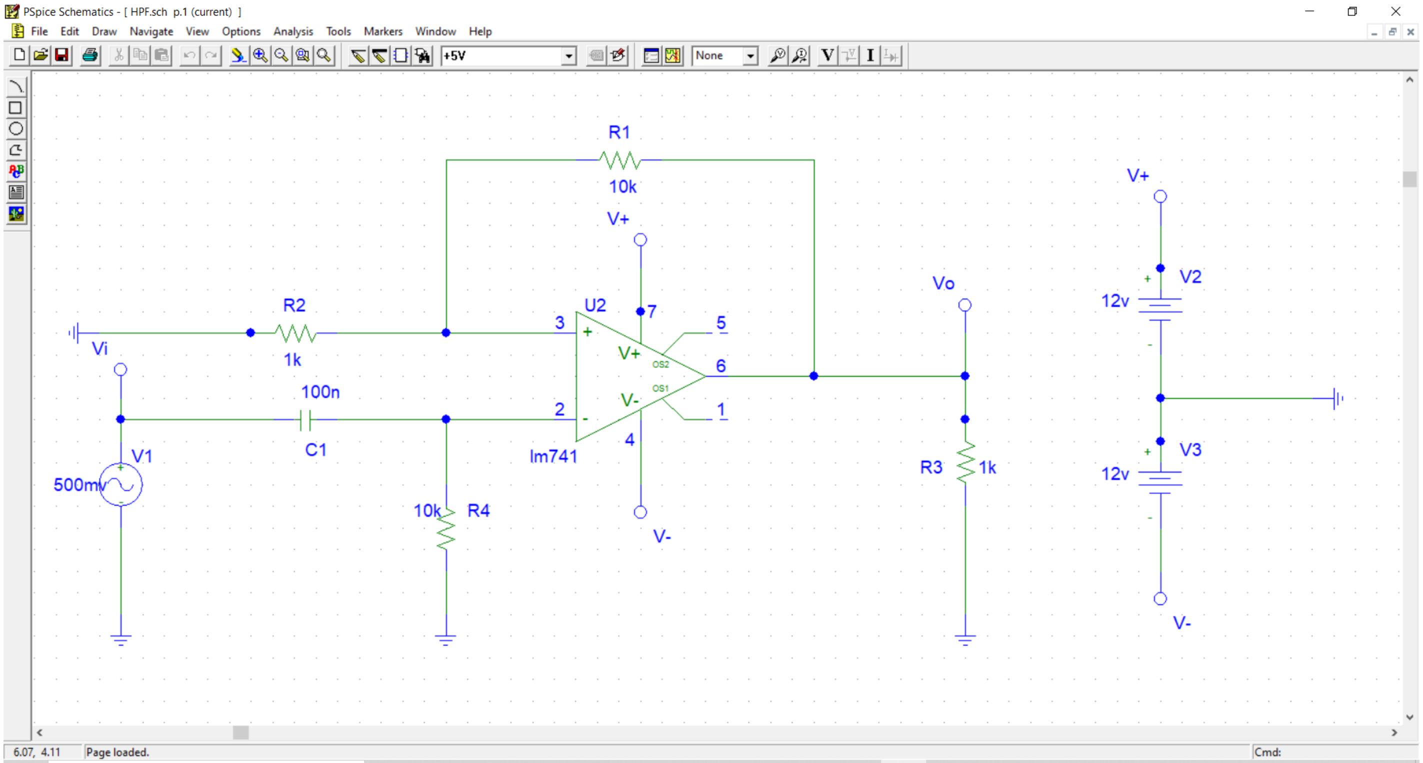
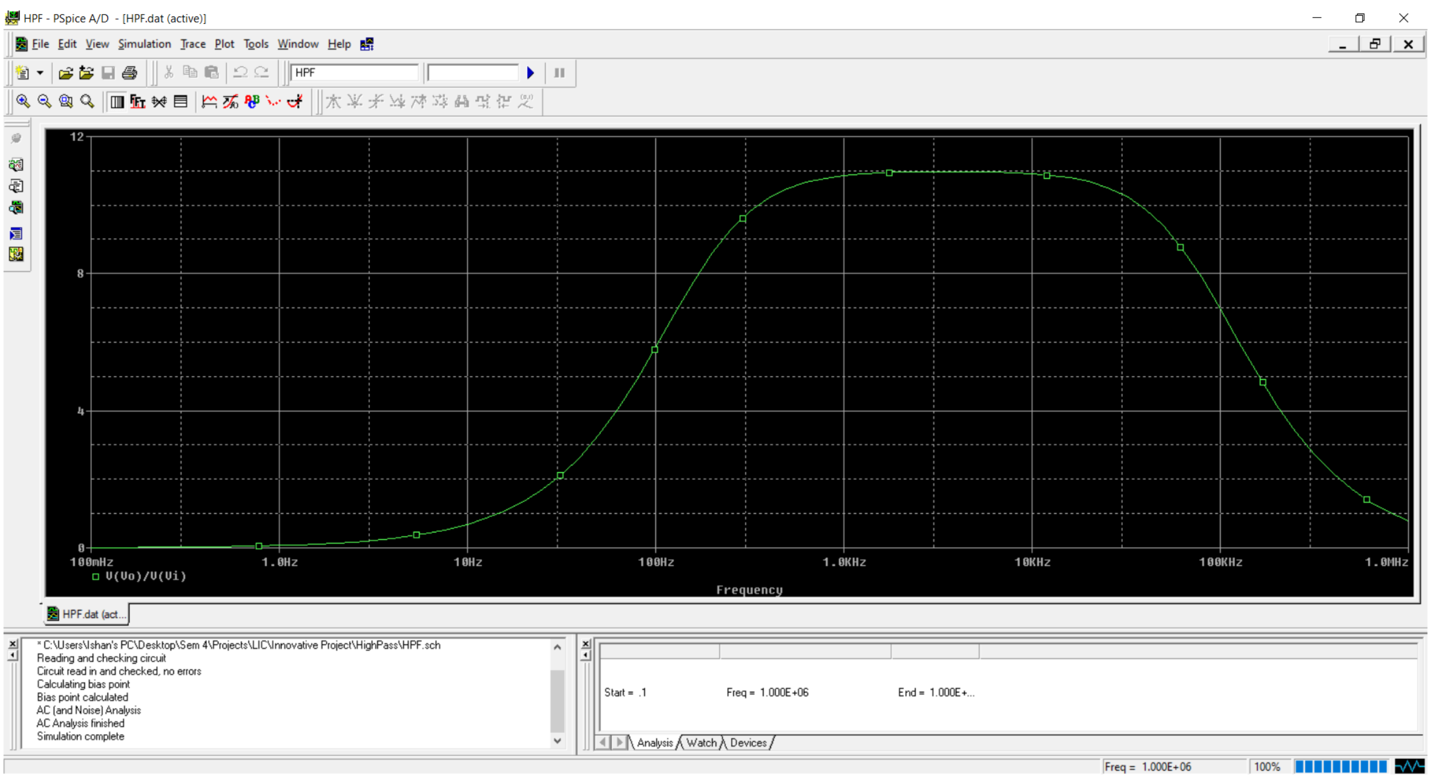
2) High-Pass Filter





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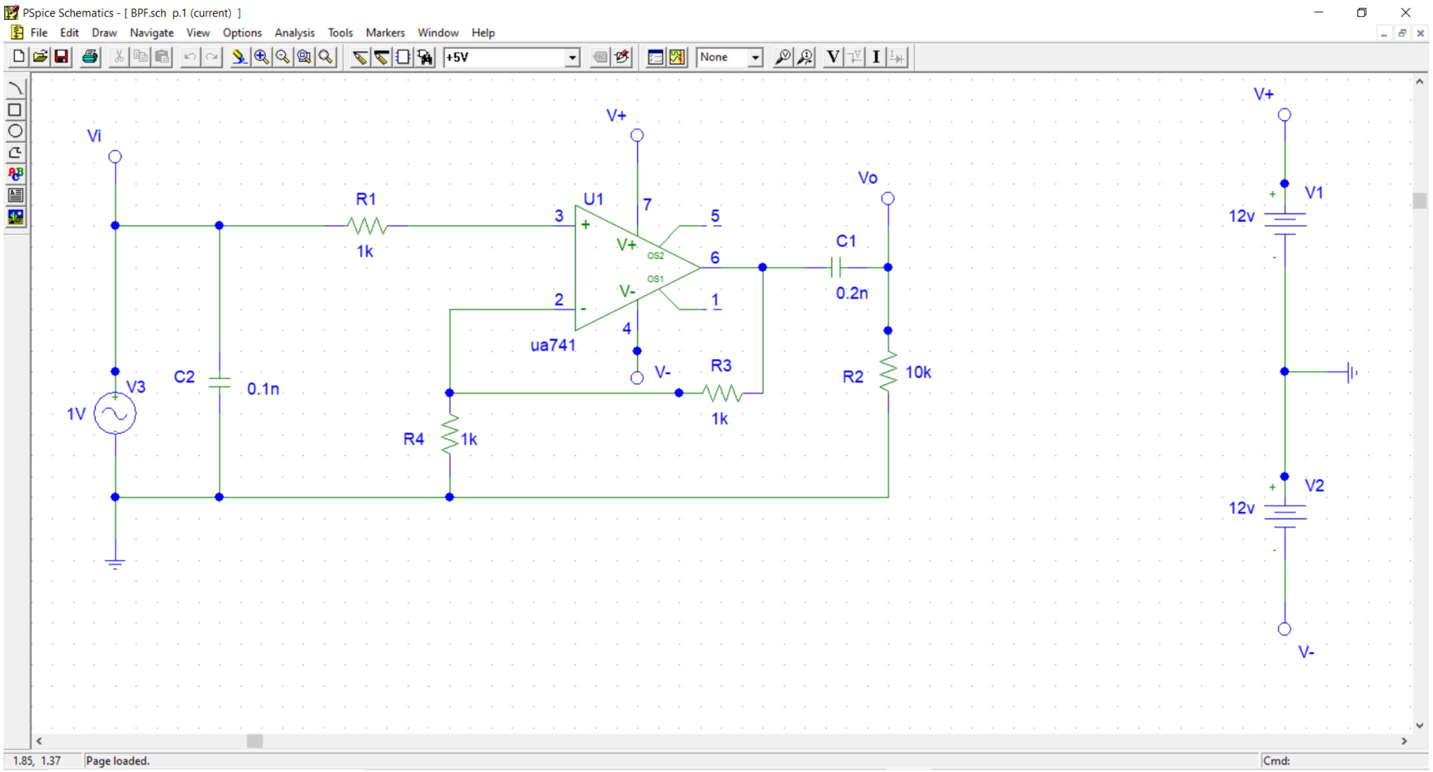
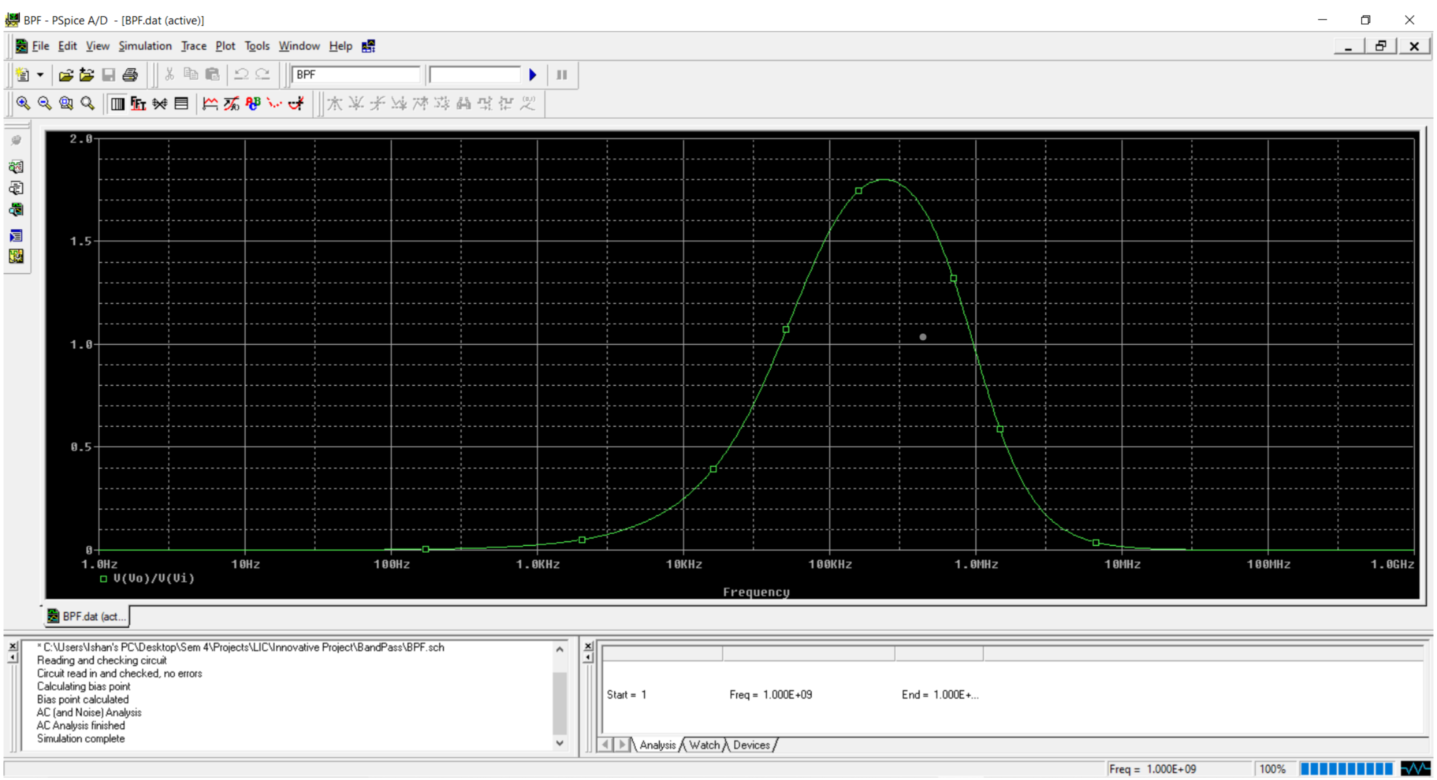
3) Band-Pass Filter





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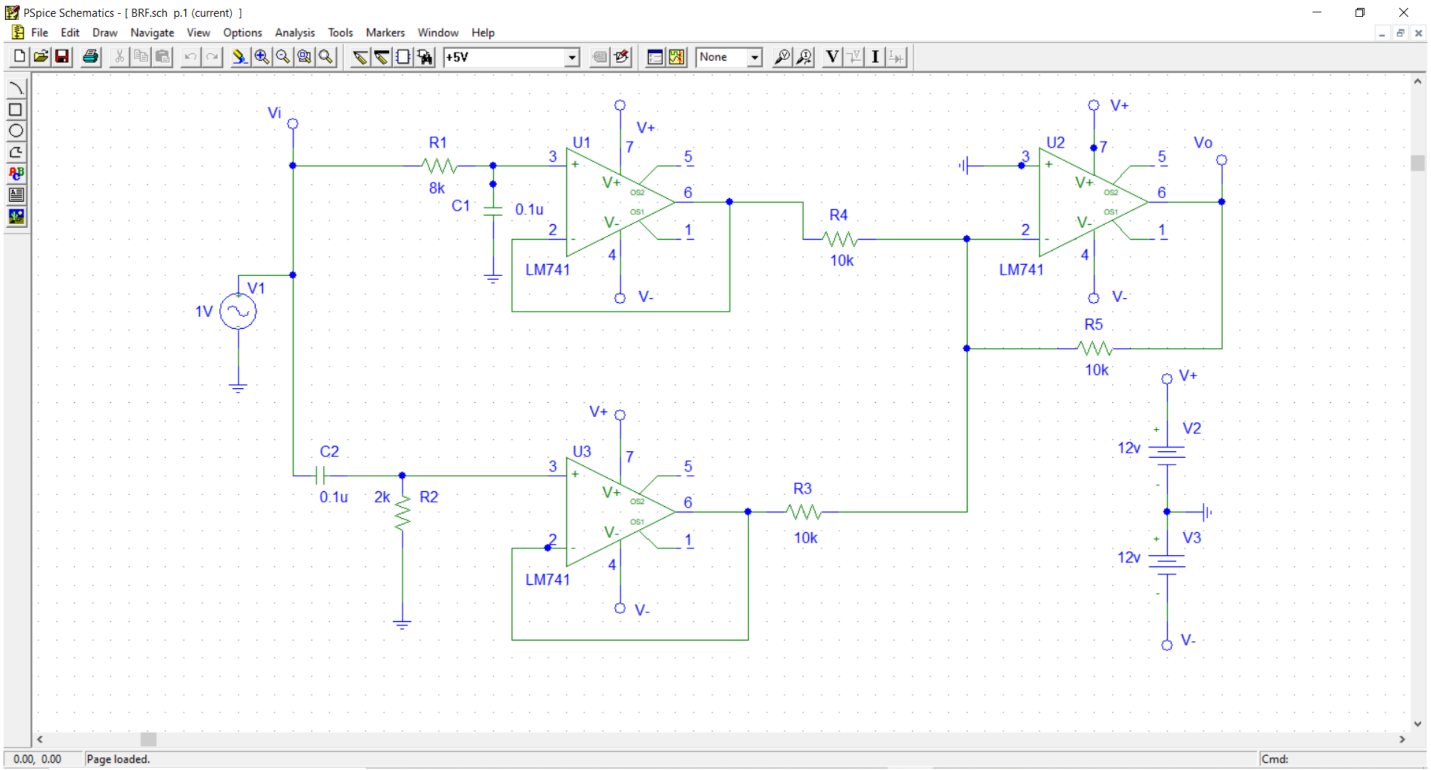
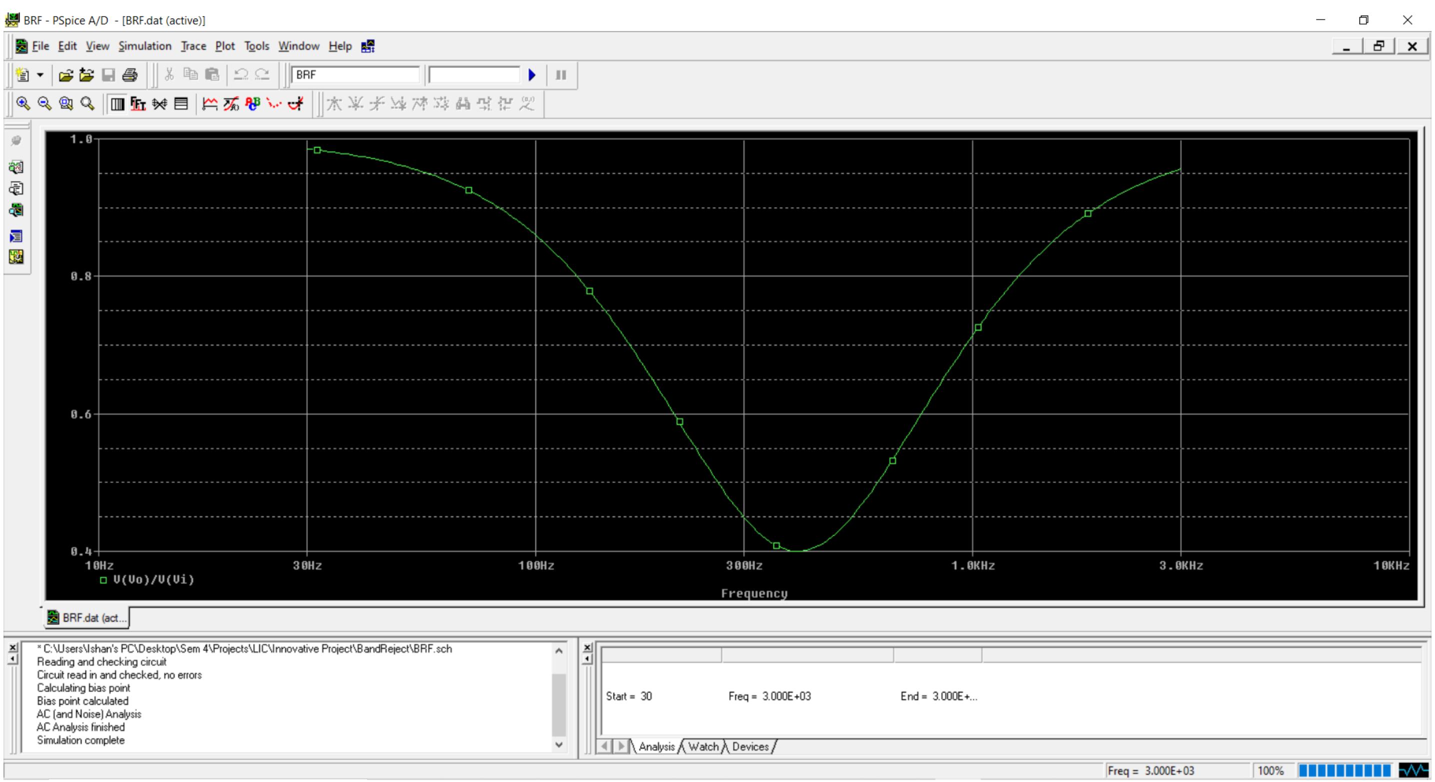
4) Band-Reject Filter





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RESULTS

The results of the simulation are exactly same as those which were expected by the theory, hence, the simulations have been successful and the project is complete.

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