Active Band Pass Filter

- **Research the filters and report their usage areas**

Low Pass Filter: Allows low-frequency signals to pass through while attenuating high-frequency signals. Usage areas include audio systems, communication systems, power supplies, and signal processing applications.

High Pass Filter: Allows high-frequency signals to pass through while attenuating low-frequency signals. Usage areas include audio systems, equalizers, crossover networks, and signal conditioning applications.

Band Pass Filter: Passes a specific range of frequencies while attenuating signals outside that range. Usage areas include RF (Radio Frequency) communication systems, wireless devices, audio amplifiers, and biomedical signal processing.

Band Stop Filter: Attenuates signals within a specific frequency range while allowing signals outside that range to pass through. Usage areas include audio systems (to remove specific hum or noise frequencies), power line interference rejection, and communication systems.

Notch Filter: A notch filter is a type of band-stop filter, which is a filter that attenuates frequencies within a specific range while passing all other frequencies unaltered. For a notch filter, this range of frequencies is very narrow. The range of frequencies that a band-stop filter attenuates is called the stopband.

All Pass Filter: Provides a constant gain across all frequencies but introduces a phase shift. Usage areas include audio phase compensation, delay lines, and phase equalizers.

Butterworth Filter: A type of low pass or high pass filter with a maximally flat frequency response in the passband or stopband, respectively. Usage areas include audio systems, analog and digital communication systems, and instrumentation. Chebyshev Filter: Provides a steeper roll-off rate at the expense of ripple in the passband or stopband. Usage areas include RF systems, satellite communication, and medical imaging.

Elliptic Filter or Cauer Filter: Combines the characteristics of both Chebyshev and Butterworth filters, providing a sharper roll-off rate with ripple in both the passband and stopband. Usage areas include digital communication systems, radar systems, and medical devices. These are just a few examples of common filters and their typical usage areas. The choice of filter depends on the specific application requirements and desired frequency response characteristics.

- **<u>Design an AC circuit by using a filter and indicate what problems you aim to solve & Explain the working principle of the designed AC circuit and the usage areas in the industry with examples</u>**

What I designed is an Active Band Pass filter, which can solve many problems with just changing the values of some components. Active Band Pass filter has 3 parts: High Pass filter; Amplification part; Low Pass filter.

Active band pass filters are commonly used in various applications where selective filtering of a specific frequency range is required. The usage areas of Active Band Pass filter:

Audio Systems: Active band-pass filters are used in audio systems to isolate specific frequency ranges, such as filtering out unwanted low-frequency noise or high-frequency interference while allowing the desired audio signals to pass through.

Communication Systems: Band-pass filters play a crucial role in communication systems, where they are used to separate different frequency bands for efficient signal transmission and reception. They help in isolating the desired frequency range and rejecting unwanted frequencies.

Instrumentation and Measurement: Active band-pass filters are employed in instrumentation and measurement systems to filter out noise, interference, or unwanted signals outside the desired frequency range. This helps in accurate signal analysis and measurements.

Biomedical Applications: In biomedical applications, active band-pass filters are used to extract specific frequency components from biological signals, such as electrocardiograms or electroencephalograms. They help in analyzing and diagnosing various physiological conditions. Wireless Communication: Band-pass filters are essential components in wireless communication systems, where they are used for frequency selection and signal conditioning. They help in isolating specific frequency bands for efficient transmission and reception of wireless signals.

Working Principle:

1. <u>High-Pass Stage:</u> The first stage of the band-pass filter is a high-pass filter section. It allows frequencies above the lower cutoff frequency to pass through while attenuating lower frequencies. The resistor determines the pass band of the high pass filter. Increasing the resistance value lowers the cutoff frequency, which is the lower limit frequency of the pass band. Higher resistance values result in lower cutoff frequencies.

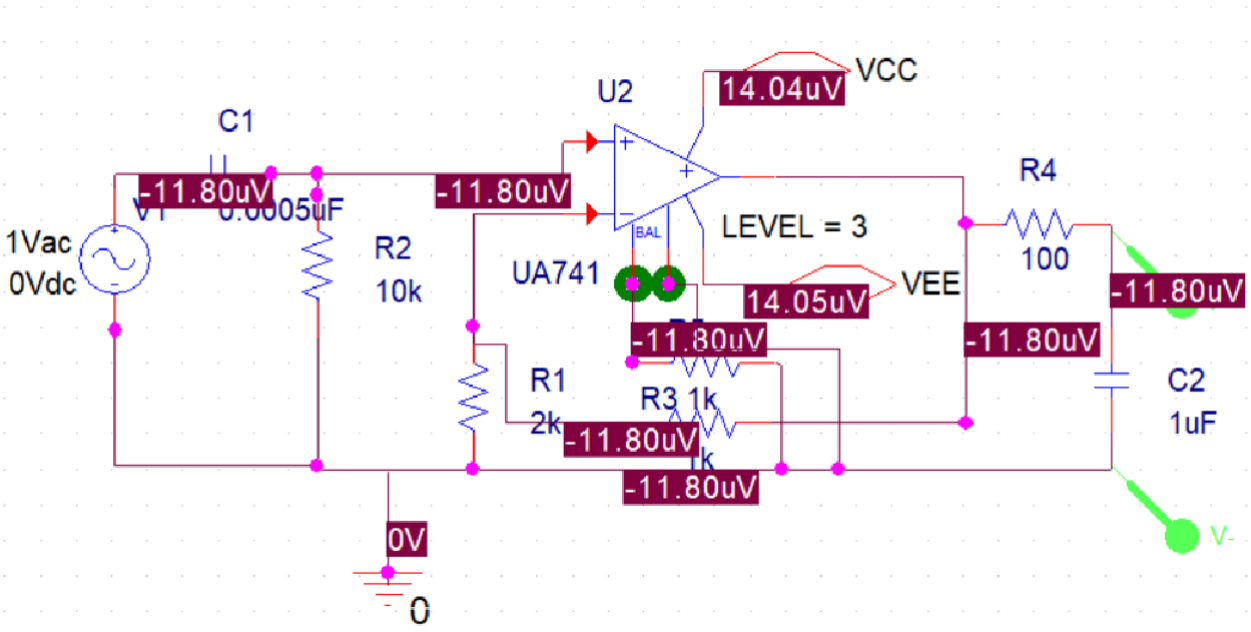
   And as the capacitor value increases, the cutoff frequency of the filter rises, and the upper limit frequency of the pass band also increases. Larger capacitors provide higher cutoff frequencies.

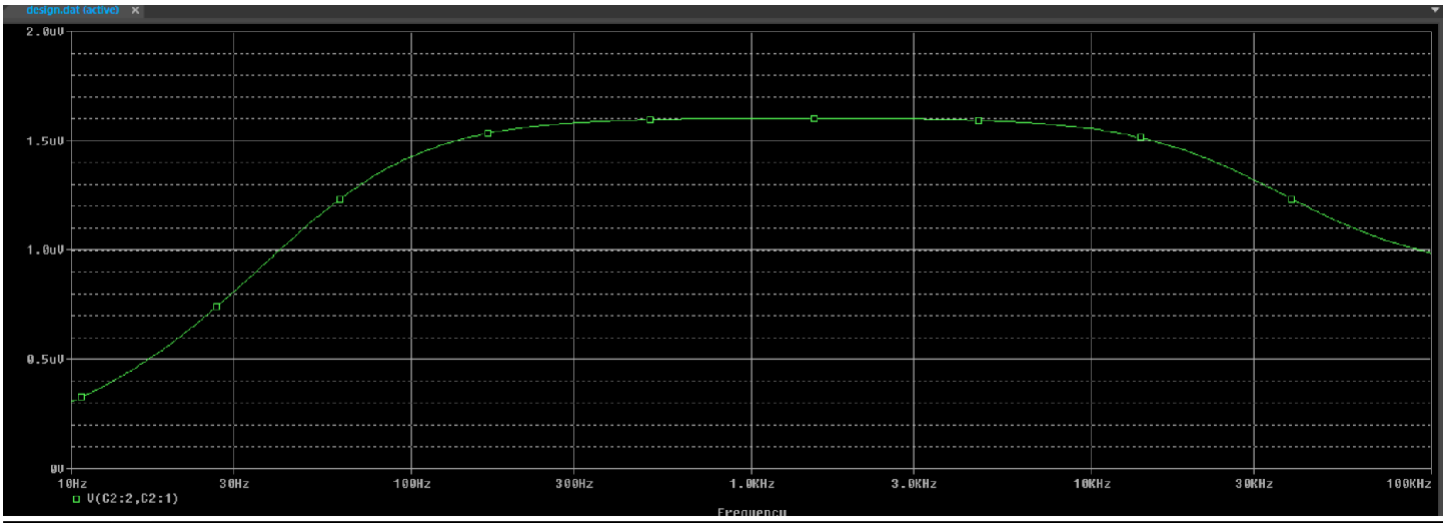
2. Op-Amp Amplification: The op-amp in the active band-pass filter circuit acts as an amplifier, providing gain to the input signal. It amplifies the signal to a desired level, ensuring that the desired frequencies are not attenuated excessively during the filtering process.

3. Low-Pass Stage: The second stage is a low-pass filter section that follows the high-pass stage. It allows frequencies below the upper cutoff frequency to pass through while attenuating higher frequencies. As the resistor value increases, the cutoff frequency decreases. In other words, a higher resistor value shifts the cutoff frequency to a lower value.

As the capacitor value increases, the cutoff frequency increases. A larger capacitor value raises the cutoff frequency of the low-pass filter.

- **<u>Show the results by simulating the AC circuit in the Pspice/Orcad. (such as voltage, current, power etc.) Analyze the results.</u>**





As seen in Voltage-Frequency graph, circuit works well and allows frequencies between 300Hz and 30kHZ.

- **Design the PCB of the AC circuit**

  Jumpers for input and output voltages, their footprint is jumper2.