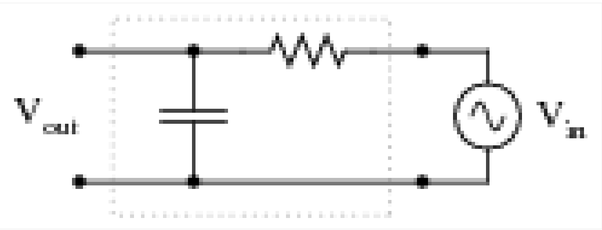
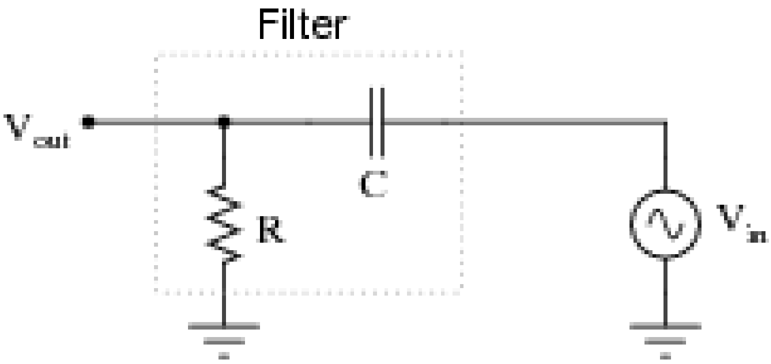
Analog Active Filter

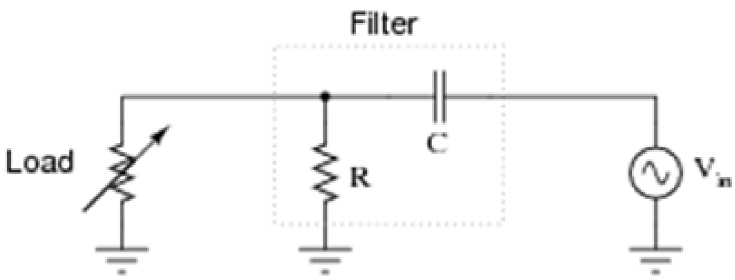
1. Draw the Bode plots for an ideal a) high-pass filter circuit b) Low pass filter: Be sure to note the "cutoff frequency" on your plot.
2. Identify what type of filter this circuit is, and calculate its cutoff frequency given a resistor value of 1 kΩ and a capacitor value of 0.22 µF: Calculate the impedance of both the resistor and the capacitor at this frequency. What do you notice about these two impedance values?



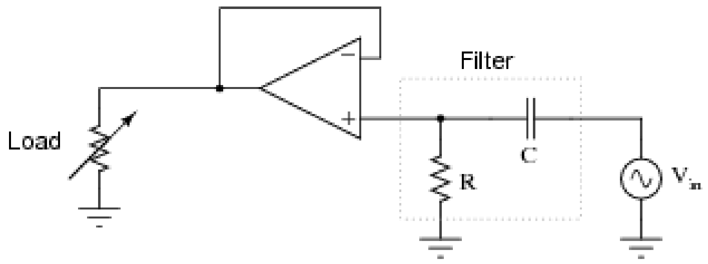
3. Identify what factor(s) determine the cutoff frequency of this passive filter circuit: Give an exact equation predicting this filter circuit's cutoff frequency, and also identify what type of filter it is.



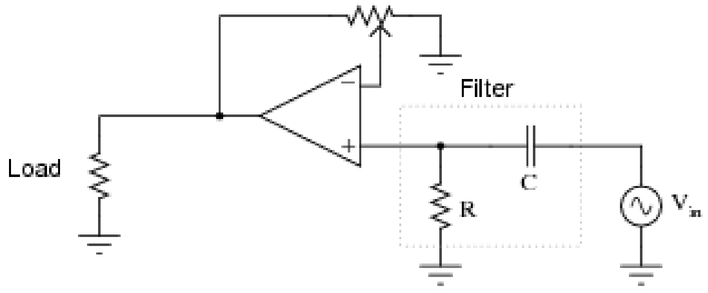
4. In this passive filter circuit, how will the filter's cutoff frequency be affected by changes in the load resistance? Be as specific as you can in your answer.



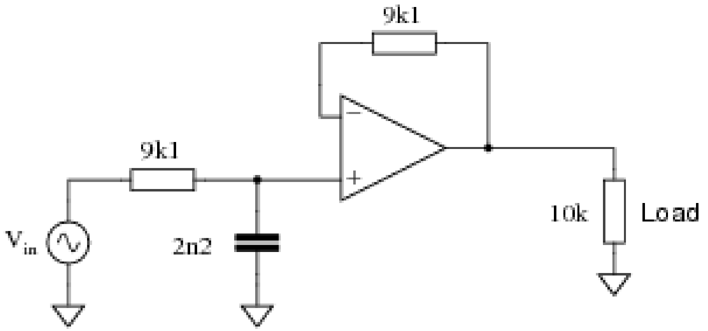
5. In this active filter circuit, how will the filter's cutoff frequency be affected by changes in the load resistance? Be as specific as you can in your answer.



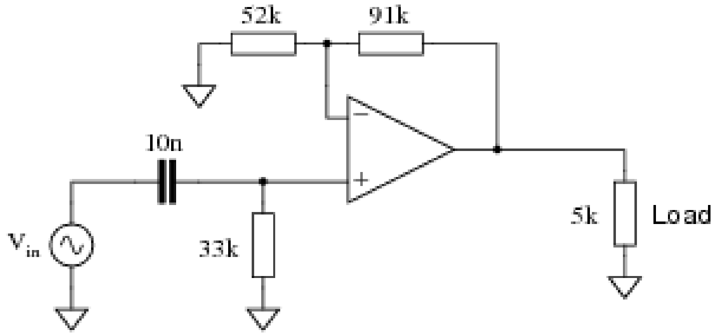
6. In this filter circuit, how will the filter's cutoff frequency be affected by changes in the potentiometer position? Be as specific as you can in your answer.



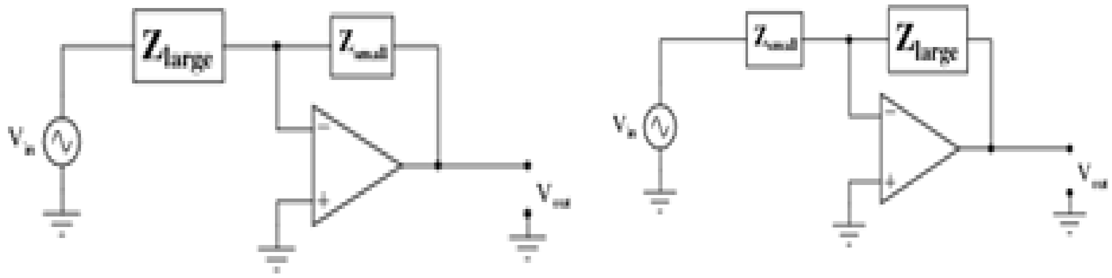
7. Determine the type and cutoff frequency of this active filter circuit:



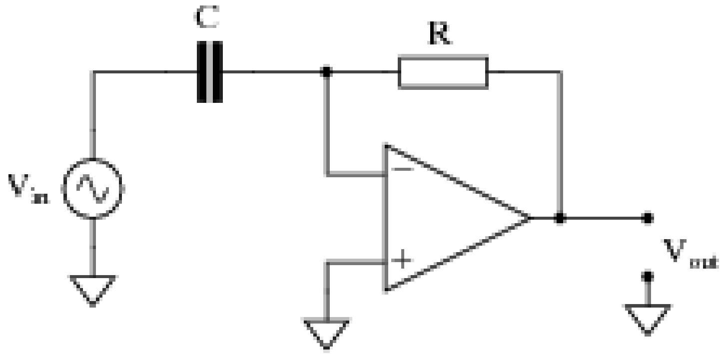
8. Determine the type and cutoff frequency of this active filter circuit:



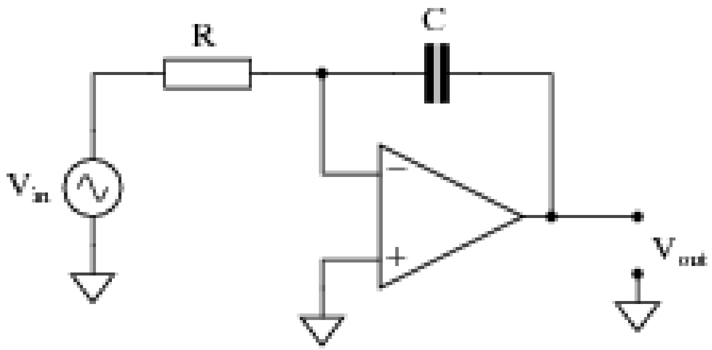
9. Compare the voltage gains of these two opamp circuits: Which one has the greater AV, and why?



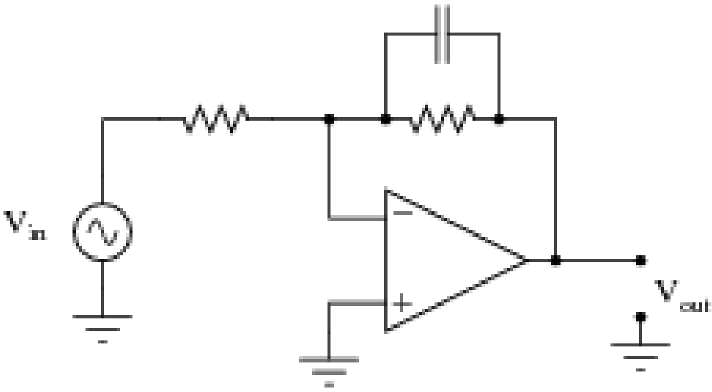
10. Describe what will happen to the impedance of both the capacitor and the resistor as the input signal frequency increases: Also, describe what result the change in impedances will have on the op-amp circuit's voltage gain. If the input signal amplitude remains constant as frequency increases, what will happen to the amplitude of the output voltage? What type of filtering function does this behavior represent?



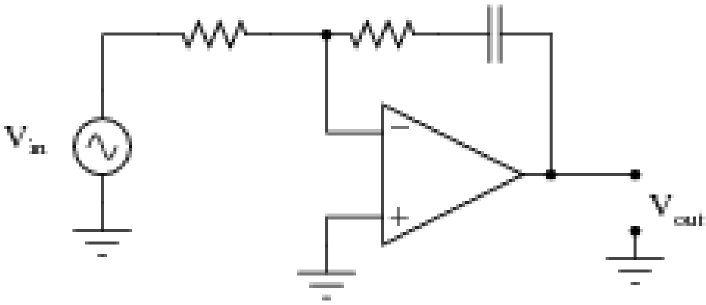
11. Describe what will happen to the impedance of both the capacitor and the resistor as the input signal frequency increases: Also, describe what result the change in impedances will have on the op-amp circuit's voltage gain. If the input signal amplitude remains constant as frequency increases, what will happen to the amplitude of the output voltage? What type of filtering function does this behavior represent?



12. Approximate the voltage gains of this active filter circuit at f = 0 and f = ∞ (assume ideal op-amp behavior):

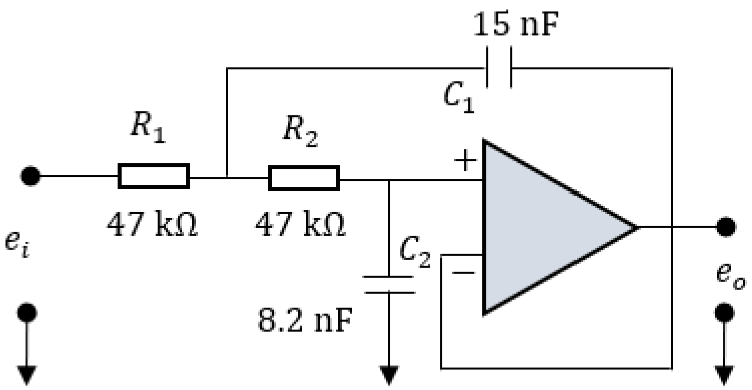


13. Approximate the voltage gains of this other "active filter" circuit at f = 0 and f = ∞ (assume ideal op-amp behavior):

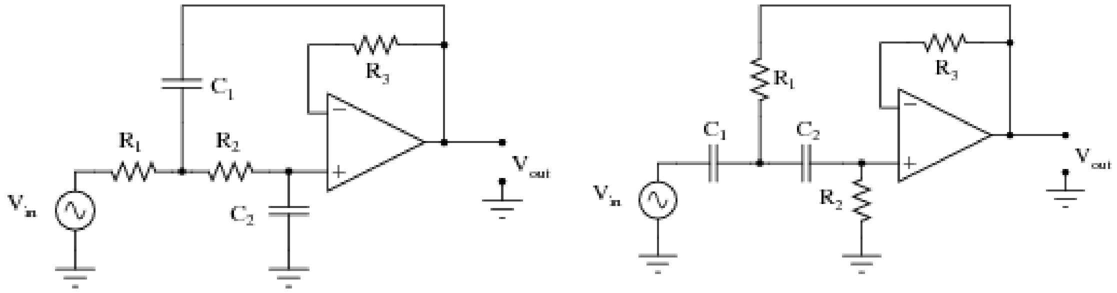


14. Figure below is a second-order Butterworth low-pass filter used in a data acquisition system. Obtain the following:

   a) the transfer function of the filter,
   b) cut-off frequency in Hz,
   c) natural frequency, and
   d) damping factor.



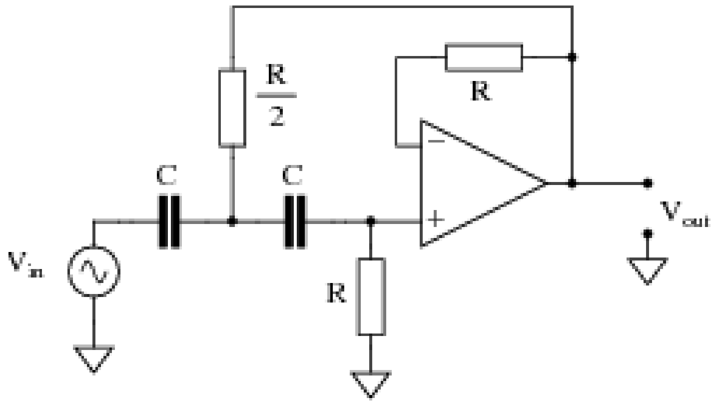
15. A very popular active filter topology is called the Sallen-Key. Two examples of Sallen-Key active filter circuits are shown here: Determine which of these Sallen-Key filters is low pass, and which is high pass. Explain your answers.



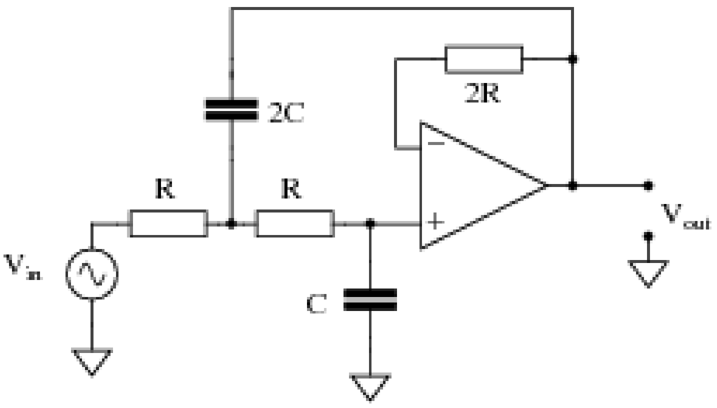
Sallen-Key active filters

16. In active and passive filter design literature, you often come across filter circuits classified as one of three different names: Chebyshev, Butterworth, or Bessel. Describe what each of these names means. What, exactly, distinguishes a "Chebyshev" filter circuit from a "Butterworth" filter circuit?

17. Choose appropriate values for this Sallen-Key high-pass filter circuit to give it a cutoff frequency of 7 kHz with a "Butterworth" response: A good guideline to follow is to make sure no component impedance (ZR or ZC) at the cutoff frequency is less than 1 kΩ or greater than 100 kΩ.

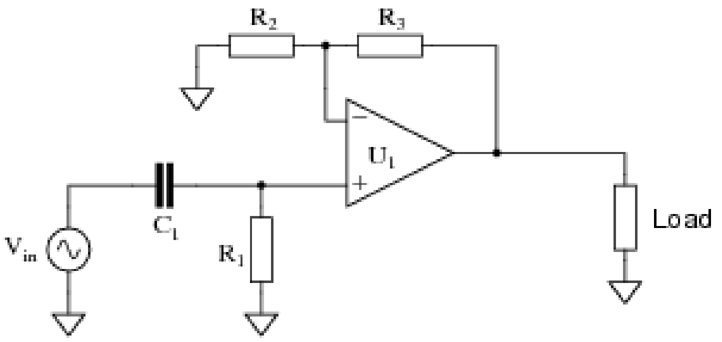


18. Choose appropriate values for this Sallen-Key low-pass filter circuit to give it a cutoff frequency of 4.2 kHz with a "Butterworth" response: A good guideline to follow is to make sure no component impedance (ZR or ZC) at the cutoff frequency is less than 1 kΩ or greater than 100 kΩ.

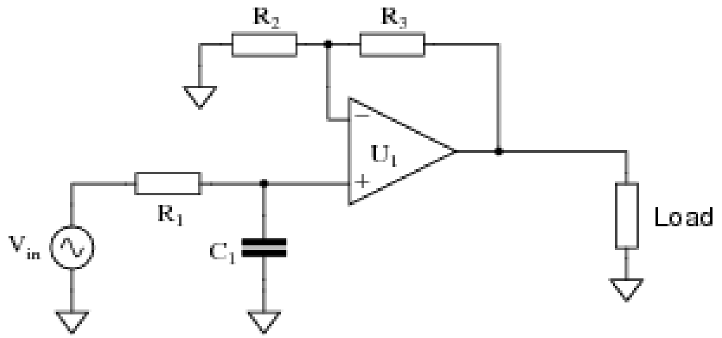


19. Predict how the operation of this active filter circuits will be affected as a result of the following faults. Consider each fault independently (i.e. one at a time, no multiple faults):
    a) Resistor R1 fails open:
    b) Capacitor C1 fails open:
    c) Solder bridge (short) across resistor R1:
    d) Solder bridge (short) across capacitor C1:
    e) Resistor R2 fails open:
    f) Resistor R3 fails open:

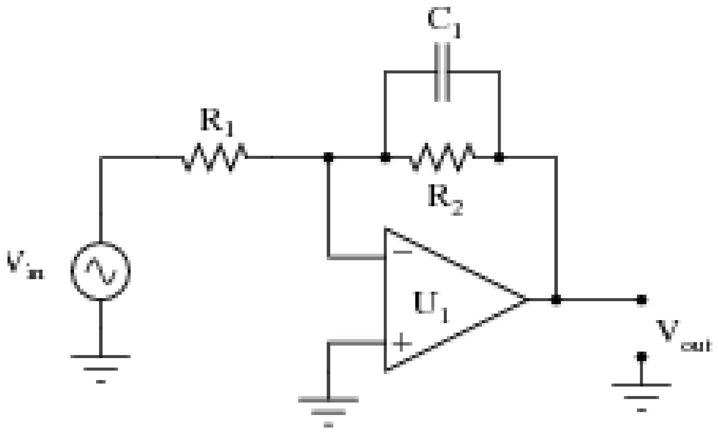
    For each of these conditions, explain why the resulting effects will occur.



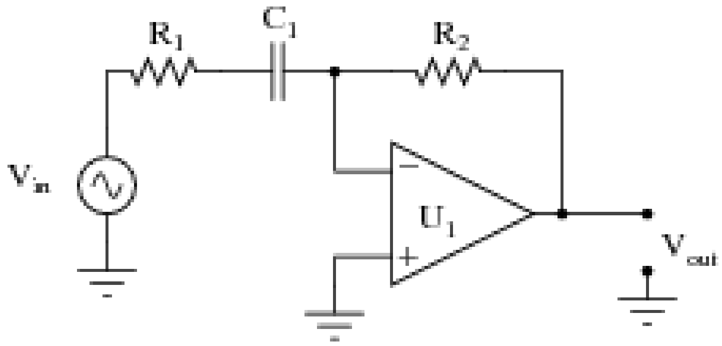
Active filter circuits (i)



Active filter circuits (ii)



Active filter circuits (iii)



Active filter circuits (ii)

Transmission Lines Measurements: High Frequencies

1. A 50-W lossless transmission line is terminated in a load $Z_L = (30 - j50)\ \Omega$. The wavelength is 8 cm. Find: the reflection coefficient at the load, and the standing-wave ratio on the line.
2. Explain how the voltage reflection coefficient describes the power reflected from the load.
3. Using a slotted line, the voltage on a lossless transmission line was found to have a maximum magnitude of 1.5 V and a minimum magnitude of 0.6 V. Find the magnitude of the load's reflection coefficient.
4. How do we minimize the power loss in transmission line?
5. Give the meaning of the term standing wave.
6. Measurement analysis is expected in a network where voltage source has an open circuit voltage of 20 V and has an output impedance of $0.5 + j1\ \Omega$. The voltage source is connected to the load through a transmission network having impedance of $1.5 + j4\ \Omega$. Find
    A. the load that maximum power transfer will be realized,
    B. the expected maximum power,

C. the expected losses in the voltage source and transmission network, and

D. the efficiency under maximum power transfer condition

7. The bandwidth of RF including microwave is approximately

A. 20 Hz to 20 kHz

B. 1 kHz to 300 GHz

C. 3 GHz to 3000 GHz

D. 3 Hz to 300 MHz

8. Identify the wrong statement.

A. Power in band is the measure of total power within a specified frequency range.

B. Occupied bandwidth measures bandwidth that contains total power of the signal.

C. Adjacent channel power measures the way a particular channel and its two adjacent channels distribute power.

D. Resolution bandwidth measures the smallest frequency that can be resolved.

9. This is not a digital modulation technique:

A. Amplitude shift keying

B. Phase shift keying

C. Frequency shift keying

D. Pulse shift keying

10. A source having an open circuit voltage of 20 V and an output impedance of (1.5 j4) Ω is connected through a transmission network of impedance (0.5 + j1)Ω. What should be the load impedance so that the maximum power will be delivered to it? Calculate the maximum deliverable power.
11. Describe the methods of measurement of voltage and power of a radio frequencies.
12. Describe the basic circuit of a spectrum analyser.
13. How can you measure the RF voltage and power using RF millivoltmeter?
14. What are the different analog-modulation techniques used in communication? Compare each of them with one another.
15. What are the different digital-modulation techniques used in communication? Compare each of them with one another.
16. How can a diode be used for measurement of RF power? Compare the bolometer with thermocouple-based RF power. metre
17. Explain the RF voltage measurement techniques with a proper circuit diagram.

18. A 25Km long Microwave lossless transmission line is operating at a frequency of 2.4GHz. The line parameters are L= 0.325μH/m and C = 130 pF/m. A 25Km long Microwave lossless transmission line is operating at a frequency of 2.4GHz. The line parameters are L= 0.325μH/m and C = 130 pF/m. Find the characteristic impedance.