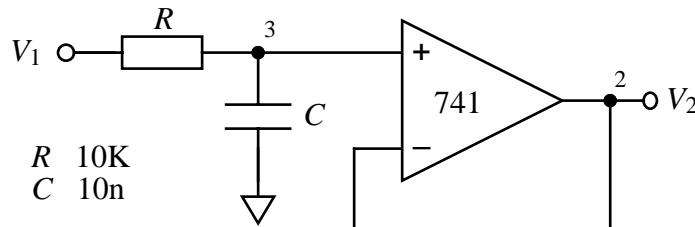


Analogue Filters

Low Pass Filters

Milestone 0

Construct circuit 6.1 and plot the magnitude (in dB) and phase (in degrees) of the measured frequency response V_2/V_1 from 10 Hz to 100 kHz on the graph paper supplied. On the same graphs plot a curves of the theoretical values for these quantities (refer to homework exercise 5.2 (a)). What is the purpose of the unity-gain amplifier in this circuit?

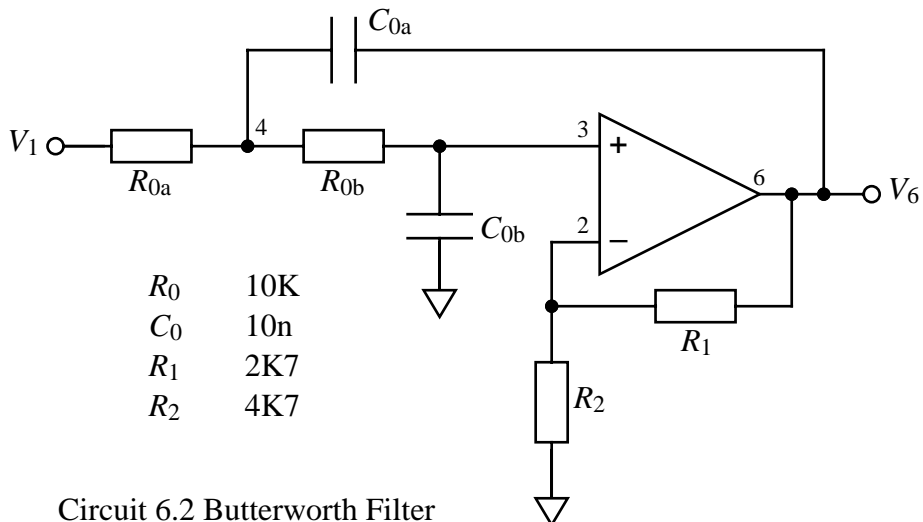


Circuit 6.1 Low-pass RC filter

Milestone 1

Nodes 1,3 and 6 in circuit 6.2 are related in the frequency domain by the function

$$V_3 = \frac{V_1 + V_6 j\omega C_0 R_0}{1 + 3j\omega C_0 R_0 - (\omega C_0 R_0)^2} \tag{6.1}$$



Circuit 6.2 Butterworth Filter

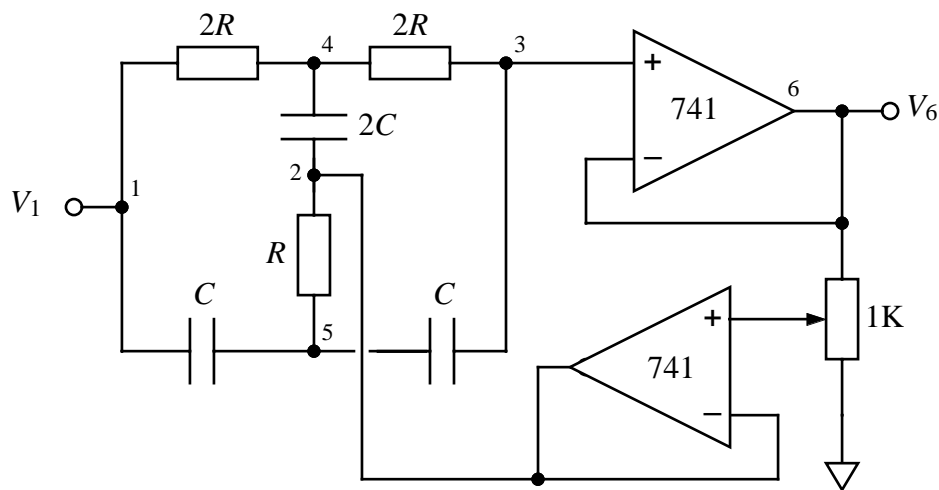
Use an ideal op-amp model to relate V_3 to V_6 and hence calculate the transfer function V_6/V_1 for this circuit and plot a graph of its magnitude (in dB) against frequency over the range 100Hz to 100kHz. Build the circuit, measure its performance and add the measured points to your graph. Use your measurements to determine the high-frequency roll-off rate (in dB octave⁻¹).

Milestone 2

Apply a 1 V peak-peak 200 Hz square-wave to the input and carefully (*i.e.* to scale and with axes labelled) sketch the output.

Now modify circuit 6.2 so that $R_2 = 10 \text{ k}\Omega$. Once again measure the frequency response and sketch the response to a square-wave input. Point out any noteworthy features and hence identify it as a Chebyshev or Bessel filter.

Milestone 3



Circuit 6.3 Parallel-T Notch Filter

Variable Q Notch-Filter

Construct circuit 6.3 using $C = 10 \text{ nF}$ and $R = 4.7 \text{ k}\Omega$; the $2R$ and $2C$ values need to be accurate so use capacitors in parallel and resistors in series to obtain them. You will need to decouple the op-amps carefully and have tidy layout if this circuit is to work well. Measure how the circuit responds to a square-wave of appropriate frequency for several settings of the potentiometer. Measure the frequency response for a representative setting of the potentiometer.

Milestone 4

Analyse the circuit and obtain an expression for its transfer function in standard form (see Worksheet 5). Why might one use this circuit instead of an LCR filter circuit (e.g. circuit 5.3)?

Milestone 5

Derive equation 6.1.

End of Bonus Mile