Op-amps with reactive components

Q1. [Problem 8.53]
The op-amp circuit shown in Figure P8.53 is used as a filter. $C = 0.1\ \mu F$, $R_1 = 1.8\ k\Omega$, $R_L = 333\ \Omega$, $R_2 = 8.2\ k\Omega$. Determine
a. Whether the circuit is a low- or high-pass filter.
b. The gain V_0/V_S in decibels in the passband (i.e. at the frequencies being passed by the filter)
c. The cutoff frequency.

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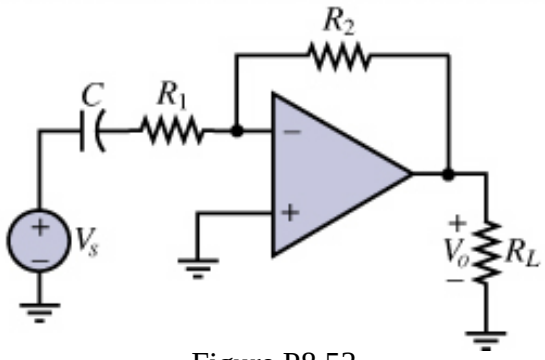


Figure P8.53

Q2. [Problem 8.57]
The op-amp circuit shown in Figure P8.57 is used as a filter. $R_1 = 9.1k\Omega$, $C = 0.47\mu F$, $R_2 = 22k\Omega$, $R_L = 2.2\ k\Omega$. Determine:
a. Whether the circuit is a low- or high-pass filter.
b. An expression in standard form for the voltage transfer function.
c. The gain in decibels in the passband (i.e. at the frequencies being passed by the filter)

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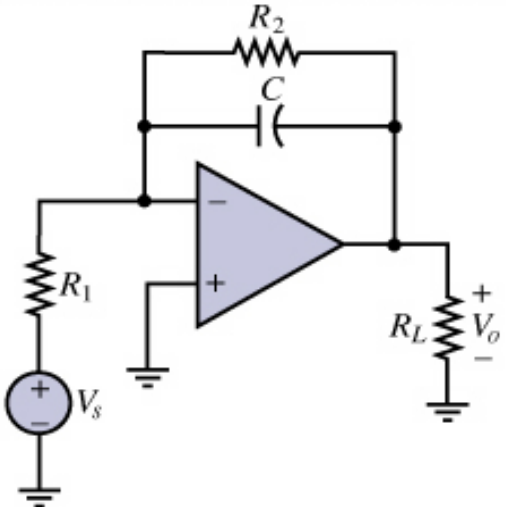


Figure P8.57

Q3. [Problem 8.61]
The circuit shown in Figure P8.61 is a bandpass filter. If $R_1 = 2.2\ k\Omega$, $C_1 = 2.2\ \mu F$, $R_2 = 100\ k\Omega$, $C_2 = 1\ nF$, determine the passband gain.

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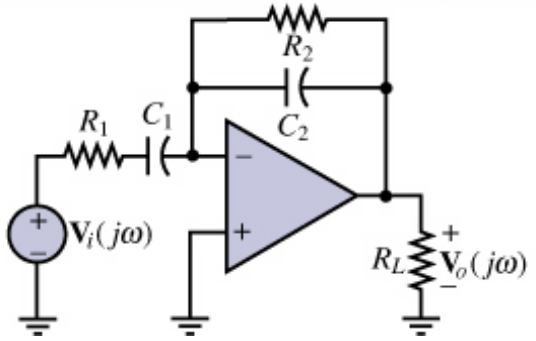


Figure P8.61

Q4. [Problem 8.59]

The circuit shown in Figure P8.59 is a bandpass filter. If $R_1 = R_2 = 10k\Omega$, $C_1 = C_2 = 0.1\mu F$, determine:

a. The passband gain
b. The resonant frequency
c. The cutoff frequencies
d. The circuit Q
e. The bode plot

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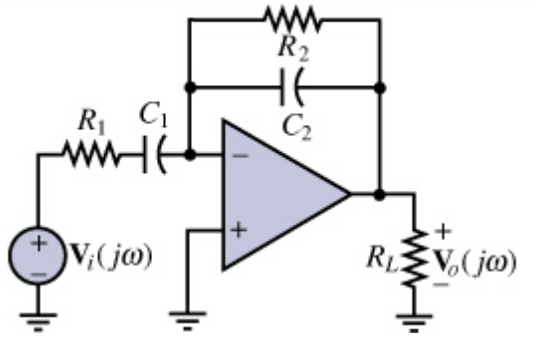


Figure P8.59

Q5. [Problem 8.55]

The circuit shown in Figure P8.55 is an active filter with $R_1 = 4.7k\Omega$, $R_2 = 68k\Omega$, $R_L = 220k\Omega$, C = 100pF. Determine the cutoff frequencies and the magnitude of the voltage frequency response function at very low and at very high frequencies.

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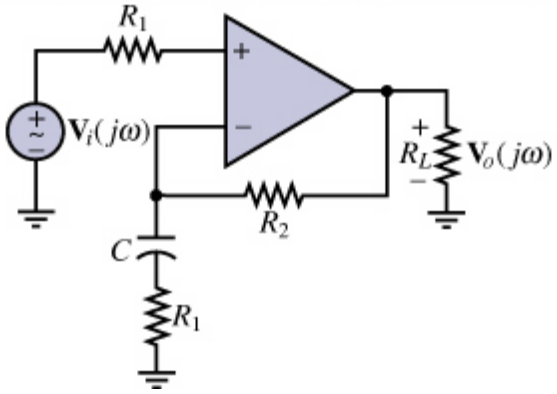


Figure P8.55

Q6. [Problem 8.56]

The circuit shown in Figure P8.56 is an active filter with $R1 = 1\text{k}\Omega$, $R3 = 80\text{k}\Omega$, $R2 = 4.7\text{k}\Omega$, $C = 20\text{nF}$. Determine:

a) An expression for the voltage frequency response function in the standard form
b) The cutoff frequencies
c) The passband gain
d) The Bode plot

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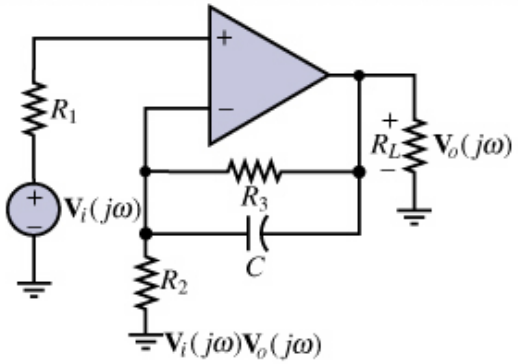


Figure P8.56

Q7. [Problem 8.11]

The circuit shown in Figure P8.11 is called a *negative impedance converter*. Determine the impedance looking in: $Z_{in} = V_1/I_1$, if

a. $Z_L = R$ and if

b. $Z_L = \dfrac{1}{j\omega C}$

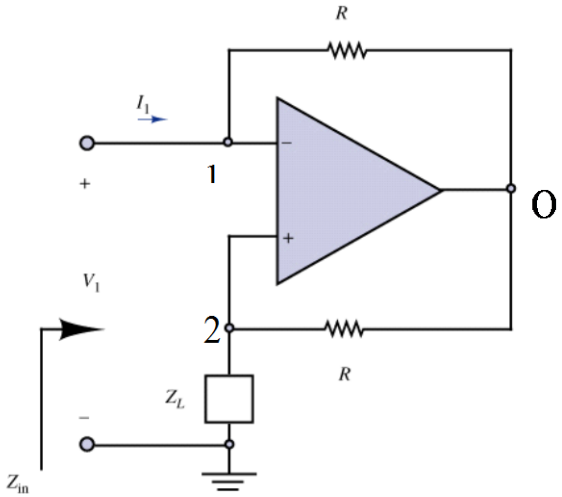


Figure P8.11

Q8. [Problem 8.12]

The circuit in Figure P8.12 demonstrates that op-amp feedback can be used to create a resonant circuit without the use of an inductor. Determine the gain function V_2/V_1. Hint: Use nodal analysis.

$$\frac{V_2}{V_1} = \frac{1}{(j\omega)^2 + j\omega/Q + 1}$$

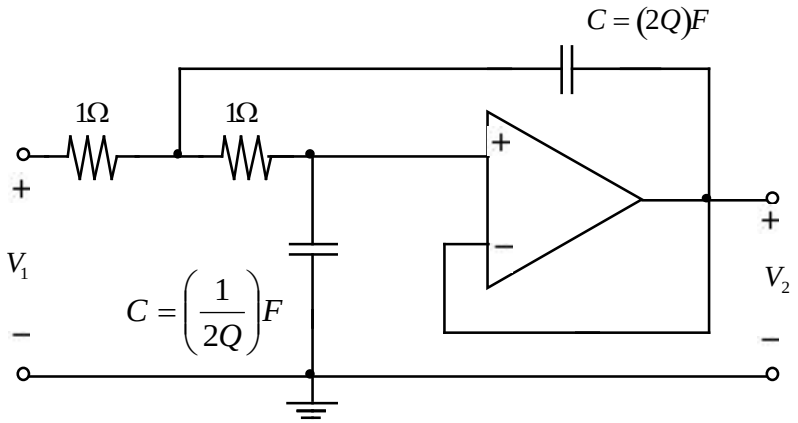


Figure P8.12

Q9. [Problem 8.14]

In the circuit of Figure P8.14, determine the impedance looking in.

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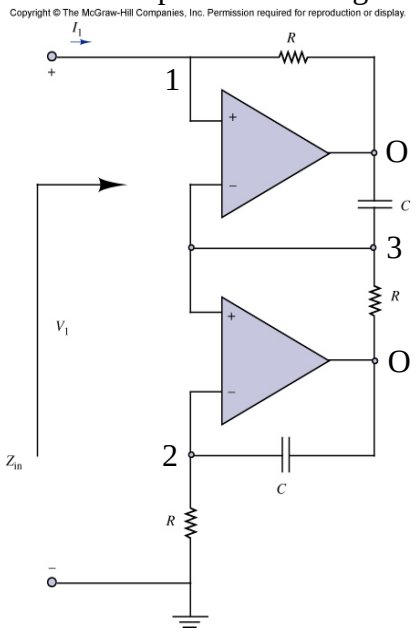


Figure P8.14

Q10. [Problem 8.22]

Consider the circuit of Figure P8.22

a. If $v_1 - v_2 = \cos(1000t)$ V, find the peak amplitude of v_{out}

b. Find the phase shift of v_{out} relative to each input

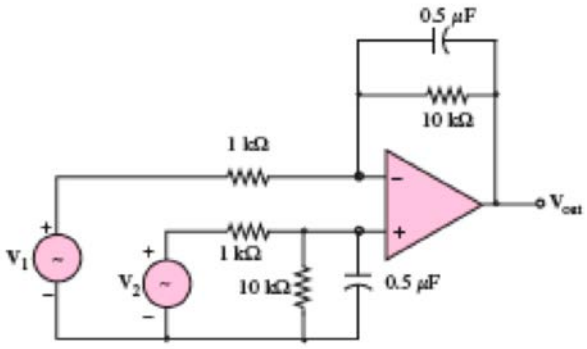


Figure P8.22

Numerical solutions

Q1. [Problem 8.53]

a. High pass filter
b. Gain = 13.17dB (from 8.2/1.8)
c. Cutoff frequency = 5555rad/s

Q2. [Problem 8.57]

a. Low pass filter
b. Gain = 7.66dB (from 22/9.1)
c. Cutoff frequency = 96.71rad/s

Q3. [Problem 8.61]

Passband gain = 45.45
Lower cutoff = 206.6rad/s, Upper cutoff = 10000rad/s

Q4. [Problem 8.59]

a) Band pass gain = 0.5
b) Resonant frequency = 1000rad/s
c) Cutoff frequencies: 414rad/s and 2414rad/s
d) Q = 0.5

Q5. [Problem 8.55]

Lower cutoff frequency = 1.375 105 rad/s
Upper cutoff frequency = 2.127 105 rad/s
At low frequency, $H_v = 1$
At high frequency, $H_v = 15.46$

Q6. [Problem 8.36]

b) Lower cutoff = 625rad/s, upper cutoff = 11263rad/s
c) Passband gain = 18 (at low frequencies)

Q7. [Problem 8.11]

a. $Z_{in} = -R$
b. $Z_{in} = -1/j\omega C$

Q9. [Problem 8.14]

$Z_{in} = (\omega CR)^2$

Q10. [Problem 8.22]

a) Peak amplitude of $V_{out} = 1.961V$
b) Phase shift = -78.7^o