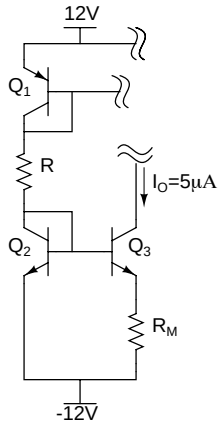
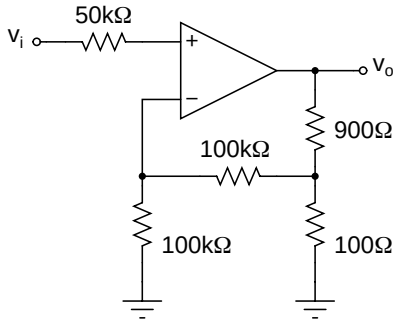
Operational Amplifiers
Extra Practice Problems

1. Design a current source using BJT transistors for an output current $I_o \simeq 2mA$. The reference current is to be derived from a $+15V$ and ground power supply using a resistor. Find the output resistance of the source if the transistors have an early voltage of $100V$.

2. Use the configuration shown below to design a current source that will provide and output current $I_O = 5\mu A$ as shown. Assume $\beta = \infty$ for all transistors and use $R_M = 5k\Omega$.

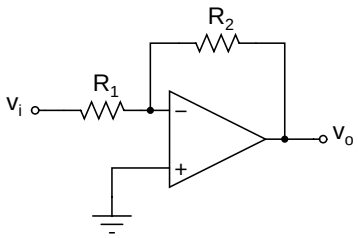


3. The operational amplifier in the following circuit is ideal.



   Find the circuit's gain $A_v = \frac{v_o}{v_i}$.

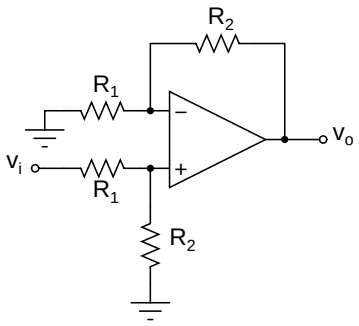
4. The amplifier shown in the following sketch has a voltage gain $A_v = -100$ and input resistance $R_{in} = 10k\Omega$.



   (a) Determine R_1 and R_2 assuming an ideal operational amplifier.

   (b) Find the circuit's bandwidth if the operational amplifier has unity gain bandwidth $\omega_\tau = 10^6 Hz$, but is otherwise ideal.

5. The amplifier shown in the following sketch has a voltage gain $A_v = +100$ and input resistance $R_{in} = 10k\Omega$.

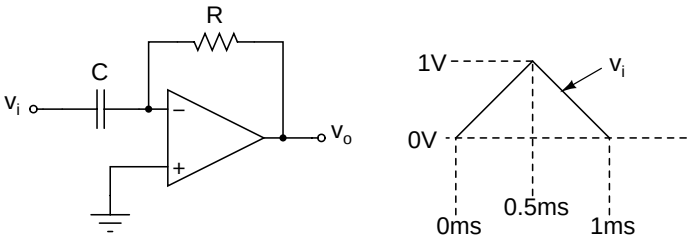


(a) Determine R_1 and R_2 assuming an ideal operational amplifier.

(b) Find the circuit's bandwidth if the operational amplifier has unity gain bandwidth $\omega_\tau = 10^6 Hz$, but is otherwise ideal.

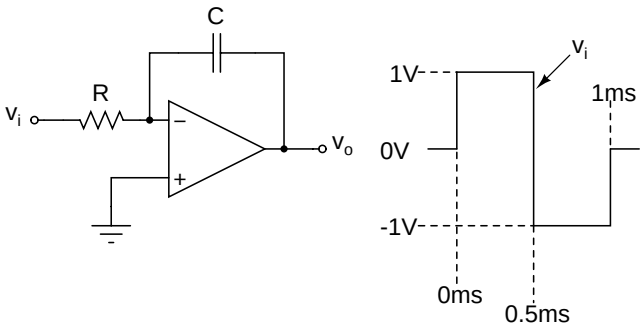
(c) Find the circuit's gain if the operational amplifier has an opel-loop gain of 10^5.

6. For the circuit shown in the following sketch, $R = 1k\Omega$ and $C = 1\mu F$. The opamp is ideal.



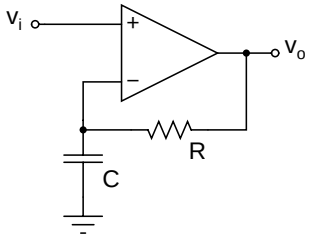
Draw the output waveform when the input voltage is the one shown on the right hand side of the figure.

7. For the circuit shown in the following sketch, $R = 1k\Omega$ and $C = 1\mu F$.



Draw the output waveform when the input voltage is the one shown on the right hand side of the figure.

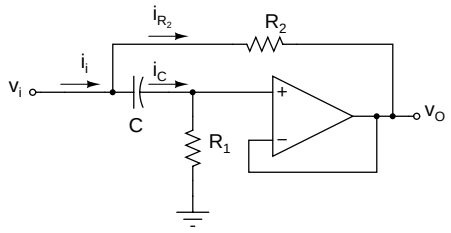
8. For the following circuit



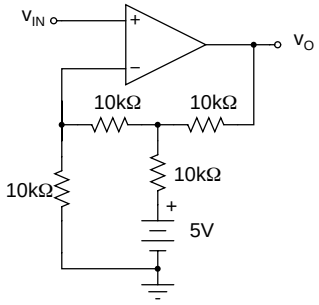
(a) Derive an expression for v_o in terms of v_i and the component values. Notice that v_i does not need to be sinusoidal.

(b) Find an expression for v_o in terms of the Laplace operator s, valid when v_i is sinusoidal.

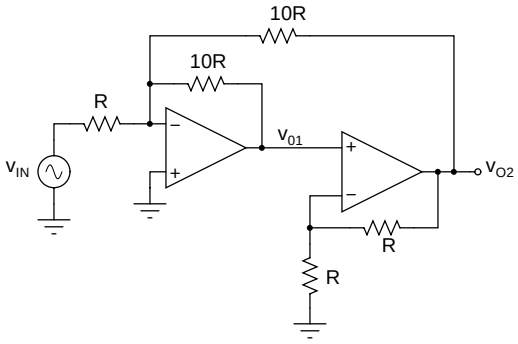
9. Determine the input impedance $Z_{in} = \frac{v_i}{i_i}$ for the following circuit. Assume an ideal opamp.



10. Find v_O in terms of v_{IN} for the following circuit.



11. Find $\frac{v_{O1}}{v_{IN}}$ and $\frac{v_{O2}}{v_{IN}}$ for the following circuit.



12. For the following circuit, express the output voltage v_O as a differential equation of v_{in} in terms of the component values.