- Feedback allows us to increase dramatically the bandwidth of a circuit by trading off gain against bandwidth.
- Feedback allows us to tailor the characteristics of an op-amp to suit a particular application. We can use feedback to overcome problems associated with the variability of the gain of the op-amp and can also either increase or decrease the input and output resistance depending on our requirements.

Exercises

15.1 What is meant by the term 'integrated circuit'?

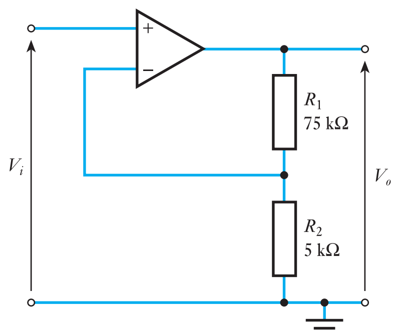
15.2 Explain the acronyms DIL and SMT as applied to IC packages.

15.3 What are typical values for the positive and negative supply voltages of an operational amplifier?

15.4 Outline the characteristics of an 'ideal' op-amp.

15.5 Sketch an equivalent circuit of an ideal operational amplifier.

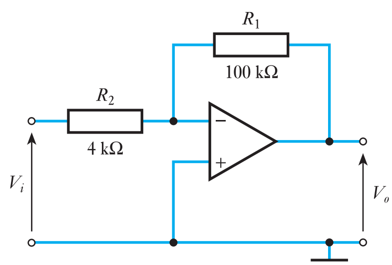
15.6 Determine the gain of the following circuit.



15.7 Sketch the circuit diagram of a non-inverting amplifier with a gain of 30.

15.8 Use circuit simulation to investigate your solution to the last exercise. Use one of the operational amplifiers supported by your simulation package and apply a DC input voltage of 100 mV. Then, confirm that the circuit works as expected.

15.9 Determine the gain of the following circuit.



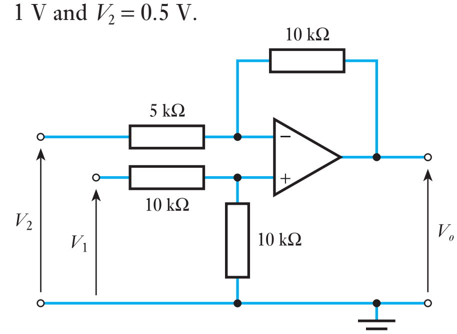
15.10 Sketch the circuit diagram of an inverting amplifier with a gain of −30.

15.11 Use circuit simulation to investigate your solution to the last exercise. Use one of the operational amplifiers supported by your simulation package and apply a DC input voltage of 100 mV. Then, confirm that the circuit works as expected.

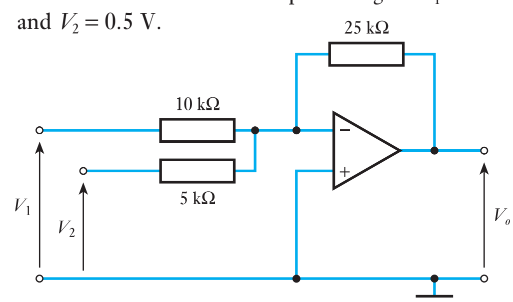
15.12 Sketch a circuit that takes two input signals, V_A and V_B, and produces an output equal to $10(V_B - V_A)$.

15.13 Sketch a circuit that takes four input signals, V_1 to V_4, and produces an output equal to $-5(V_1 + V_2 + V_3 + V_4)$.

15.14 Derive an expression for the output V_o of the following circuit in terms of the input voltages V_1 and V_2 and hence determine the output voltage if V_1 = 1 V and V_2 = 0.5 V.

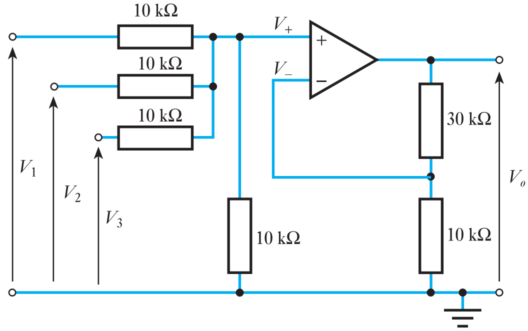


15.15 Derive an expression for the output V_o of the following circuit in terms of the input voltages V_1 and V_2 and hence determine the output voltage if V_1 = 1 V and V_2 = 0.5 V.



Exercises continued

15.16 Derive an expression for the output voltage V_o of the following circuit in terms of the input voltages V_1, V_2 and V_3 and the component values.



15.17 Simulate the circuit of Exercise 15.16 using one of the operational amplifiers supported by your simulation package. Apply appropriate input signals and hence confirm your answer to this exercise.

15.18 What are typical ranges for the open-circuit voltage gain, input resistance and output resistance of general-purpose operational amplifiers?

15.19 What are typical ranges for the supply voltages of general-purpose operational amplifiers?

15.20 What is meant by the term 'common-mode rejection ratio'? What would be a typical CMRR for a general-purpose op-amp?

15.21 Explain the term 'input bias current'.

15.22 Define the term 'input offset voltage' and give a typical figure for this quantity. How may the effects of the input offset voltage be reduced?

15.23 Sketch a typical frequency response for a 741 op-amp. What is its upper cut-off frequency? What is its lower cut-off frequency?

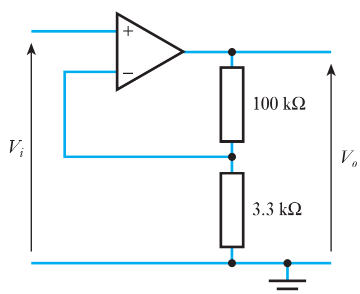
15.24 Give a typical value for the gain–bandwidth product of a 741. How does this relate to the unity gain bandwidth?

15.25 If an amplifier with a gain of 25 is constructed using a 741, what would be a typical value for the bandwidth of this circuit?

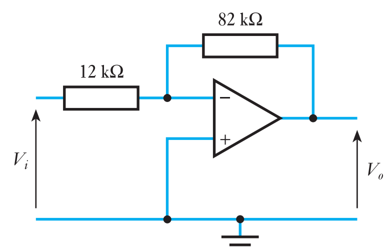
15.26 What is meant by the 'slew rate' of an op-amp? What would be a typical value for this parameter?

15.27 What range of resistor values would normally be used for circuits based on a bipolar operational amplifier?

15.28 Estimate the gain, input resistance and output resistance of the following circuits at low frequencies, assuming that each is constructed using an operational amplifier that has an open-loop gain of 10^6, input resistance of $10^6\ \Omega$ and output resistance of $100\ \Omega$.



(a)



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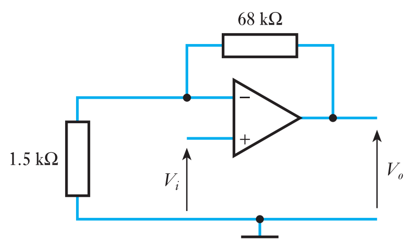

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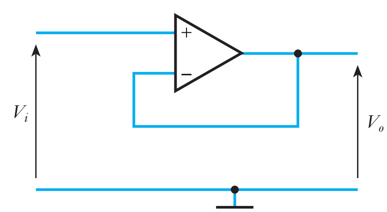

(d)