the output voltage of the op amp can be expressed as

$$v_O = A_d v_{Id} + A_{cm} v_{Icm}$$

where A_d is the differential gain (referred to simply as A in the text) and A_{cm} is the common-mode gain (assumed to be zero in the text). The op amp's effectiveness in rejecting common-mode signals is measured by its CMRR, defined as

$$\text{CMRR} = 20\log\left|\frac{A_d}{A_{cm}}\right|$$

Consider an op amp whose internal structure is of the type shown in Fig. E2.3 except for a mismatch ΔG_m between the transconductances of the two channels; that is,

$$G_{m1} = G_m - \tfrac{1}{2}\Delta G_m$$

$$G_{m2} = G_m + \tfrac{1}{2}\Delta G_m$$

Find expressions for A_d, A_{cm}, and CMRR. What is the maximum permitted percentage mismatch between the two G_m values if a minimum CMRR of 60 dB is required?

Section 2.2: The Inverting Configuration

2.9 Assuming ideal op amps, find the voltage gain v_o/v_i and input resistance R_{in} of each of the circuits in Fig. P2.9.

2.10 A particular inverting circuit uses an ideal op amp and two 10-kΩ resistors. What closed-loop gain would you expect? If a dc voltage of +1.00 V is applied at the input, what outputs result? If the 10-kΩ resistors are said to be "1% resistors," having values somewhere in the range (1 ± 0.01) times the nominal value, what range of outputs would you expect to actually measure for an input of precisely 1.00 V?

2.11 You are provided with an ideal op amp and three 10-kΩ resistors. Using series and parallel resistor combinations, how many different inverting-amplifier circuit topologies are possible? What is the largest (noninfinite) available voltage gain magnitude? What is the smallest (nonzero) available gain magnitude? What are the input resistances in these two cases?

SIM **2.12** For ideal op amps operating with the following feedback networks in the inverting configuration, what closed-loop gain results?

(a) $R_1 = 10\text{ k}\Omega, R_2 = 20\text{ k}\Omega$
(b) $R_1 = 10\text{ k}\Omega, R_2 = 100\text{ k}\Omega$
(c) $R_1 = 10\text{ k}\Omega, R_2 = 5\text{ k}\Omega$
(d) $R_1 = 100\text{ k}\Omega, R_2 = 5\text{ M}\Omega$
(e) $R_1 = 100\text{ k}\Omega, R_2 = 0.5\text{ M}\Omega$

D 2.13 Given an ideal op amp, what are the values of the resistors R_1 and R_2 to be used to design amplifiers with the closed-loop gains listed below? In your designs, use at least one 10-kΩ resistor and another equal or larger resistor.

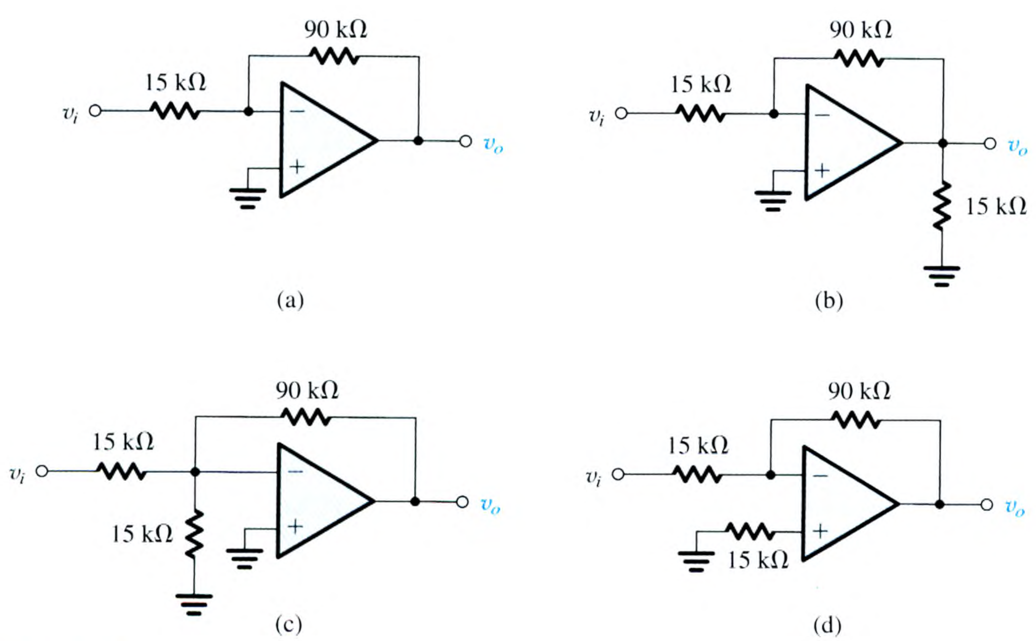

Figure P2.9