Computer Simulation Problems

SIM Problems identified by this icon are intended to demonstrate the value of using SPICE simulation to verify hand analysis and design, and to investigate important issues such as allowable signal swing and amplifier nonlinear distortion. Instructions to assist in setting up simulations for all the indicated problems can be found in the corresponding files on the website. Note that if a particular parameter value is not specified in the problem statement, you are to make a reasonable assumption.

Section 2.1: The Ideal Op Amp

2.1 What is the minimum number of pins required for a so-called dual-op-amp IC package, one containing two op amps? What is the number of pins required for a so-called quad-op-amp package, one containing four op amps?

2.2 The circuit of Fig. P2.2 uses an op amp that is ideal except for having a finite gain A. Measurements indicate $v_O = 2.5$ V when $v_I = 1.0$ V. What is the op-amp gain A?

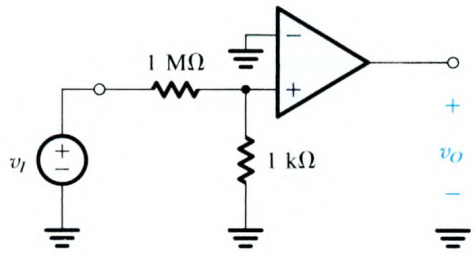

Figure P2.2

2.3 Measurement of a circuit incorporating what is thought to be an ideal op amp shows the voltage at the op-amp output to be −3.500 V and that at the negative input to be −1.000 V. For the amplifier to be ideal, what would you expect the voltage at the positive input to be? If the measured voltage at the positive input is −1.002 V, what is likely to be the actual gain of the amplifier?

2.4 A set of experiments is run on an op amp that is ideal except for having a finite gain A. The results are tabulated below. Are the results consistent? If not, are they reasonable, in view of the possibility of experimental error? What do they show the gain to be? Using this value, predict values of the measurements that were accidentally omitted (the blank entries).

Experiment #	v_1	v_2	v_O
1	0.00	0.00	0.00
2	−1.00	−1.00	0.00
3		−1.00	−1.00
4	1.00	1.02	4.01
5	2.01	2.00	−1.99
6	1.99	2.00	2.00
7	5.10		−5.10

***2.5** Refer to Exercise 2.3. This problem explores an alternative internal structure for the op amp. In particular, we wish to model the internal structure of a particular op amp using two transconductance amplifiers and one transresistance amplifier. Suggest an appropriate topology. For equal transconductances G_m and a transresistance R_m, find an expression for the open-loop gain A. For $G_m = 100$ mA/V and $R_m = 1 \times 10^5\ \Omega$, what value of A results?

2.6 Two amplifier inputs are expressed in each row of the table below either in terms of their node voltages with respect to ground, v_1 and v_2, or in terms of their differential and common-mode voltages, v_{Id} and v_{Icm}. Complete the table.

v_1	v_2	v_{Id}	v_{Icm}
0.90	0.90		
		0.50	1.00
−1.20			−1.10
−0.15	0.05		
		−0.20	0.00

2.7 The two wires leading from the output terminals of a transducer pick up an interference signal that is a 60-Hz, 2-V sinusoid. The output signal of the transducer is sinusoidal of 5-mV amplitude and 1000-Hz frequency. Give expressions for v_{cm}, v_d, and the total signal between each wire and the system ground.

2.8 Nonideal (i.e., real) operational amplifiers respond to both the differential and common-mode components of their input signals (refer to Fig. 2.4 for signal representation). Thus