UNIVERSITY OF CALIFORNIA
Electrical Engineering and Computer Sciences

145L MIDTERM #1 (take-home)
September 20, 1993

Due Monday, September 27, 1993

(100 points total, 3 points deducted for each school day late)
(no credit after graded midterms have been returned to students)

PROBLEM 1 (18 points)

Do problem 2.1 in the course reader (pages 86- 87).

PROBLEM 2 (18 points)

Do problem 2.5 in the course reader (page 88).

PROBLEM 3 (14 points):

Do problem 2.9 in the course reader (page 90).

PROBLEM 4 (18 points)

Do problem 2.14 in the course reader (pages 91-92), but omit part d.

PROBLEM 5 (8 points)

The classic instrumentation amplifier circuit is shown in figure 2.13 of the course reader (page 82).

Assume the following:

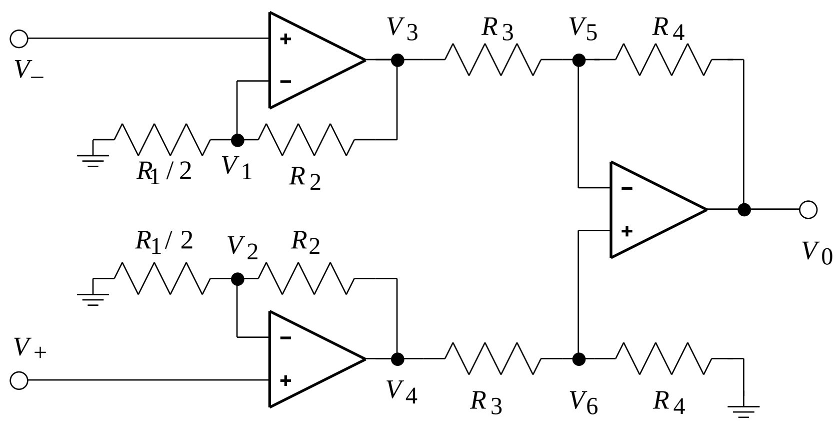
- $R_1 = 100\ \Omega$, $R_2 = 5\ k\Omega$, $R_3 = 1\ k\Omega$, $R_4 = 10\ k\Omega$.
- Input V_+ = +1 volt d.c. plus 1 mV p-p (peak-to-peak) sine wave at 1 kHz
- Input V_- = +1 volt d.c. plus 1 mV p-p sine wave at 1 kHz
- Differential input $(V_+ - V_-)$ = 2 mV p-p sine wave at 1 kHz
- Power supply voltages are –10V and + 10V

Answer the following (you may use the results of the example derivation on pages 63-64):

a. What are the amplitudes of the d.c. and 1 kHz components of V_3?
b. What are the amplitudes of the d.c. and 1 kHz components of V_4?
c. What are the amplitudes of the d.c. and 1 kHz components of $V_4 - V_3$?
d. What are the amplitudes of the d.c. and 1 kHz components of V_0?

PROBLEM 6 (16 points)

A new instrumentation amplifier circuit has been proposed, as shown below:



Assume the following (same values as Problem 5):

- $R_1/2 = 50\ \Omega$, $R_2 = 5\ k\Omega$, $R_3 = 1\ k\Omega$, $R_4 = 10\ k\Omega$.
- Input V_+ = +1 volt d.c. plus 1 mV p-p sine wave at 1 kHz
- Input V_- = +1 volt d.c. plus 1 mV p-p sine wave at 1 kHz
- Differential input $(V_+ - V_-)$ = 2 mV p-p sine wave at 1 kHz
- Power supply voltages are –10V and + 10V

Answer the following:

a. What are the amplitudes of the d.c. and 1 kHz components of V_3?

b. What are the amplitudes of the d.c. and 1 kHz components of V_4?

c. What are the amplitudes of the d.c. and 1 kHz components of $V_4 - V_3$?

d. What are the amplitudes of the d.c. and 1 kHz components of V_0?

e. Is this circuit design better than the one in Problem 5? Explain your answer.

PROBLEM 7 (8 points)

The formula for the gain of the noninverting amplifier (Course Reader figure 2.3, page 53) is given by:

$$G_\pm = \frac{V_0}{V_+ - V_-} = \frac{R_1 + R_2}{R_1}$$

Assume that 10% accuracy resistors are used with values $R_1 = 1\ k\Omega$, $R_2 = 4k\Omega$,

a. what is the gain $G_\pm$?

b. what is the accuracy of $G_\pm$?

(Hint: use the error propagation formulas given in class and assume that “10% accuracy” means “standard deviation = 10%”)