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:
- $R_1 = 100 \Omega$, $R_2 = 5 \text{k}\Omega$, $R_3 = 1 \text{k}\Omega$, $R_4 = 10 \text{k}\Omega$.
- Input $V_+ = +1 \text{ volt d.c.} \text{ plus 1 mV p-p (peak-to-peak) sine wave at 1 kHz}$
- Input $V_- = +1 \text{ volt d.c.} \text{ plus 1 mV p-p sine wave at 1 kHz}$
- Differential input $(V_+ - V_-) = 2 \text{ mV p-p sine wave at 1 kHz}$
- 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:

![Circuit Diagram]

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%”)