ECE 3042

Homework Assignment No. 4

Fall 2009 Homework for Experiment No. 4

Due Week of September 28

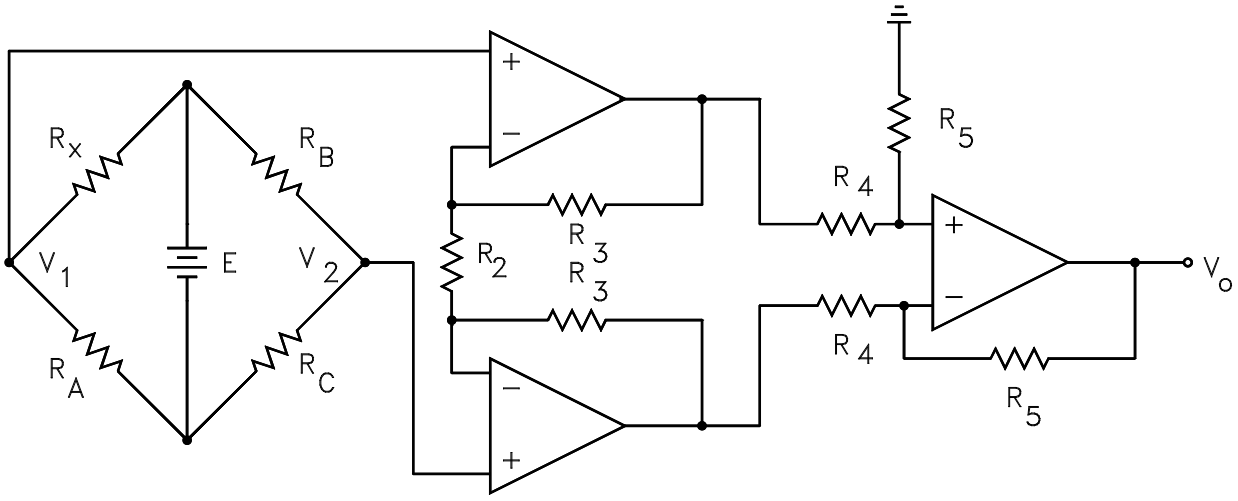

Fig. 1. Bridge Sensor

1.Shown in Fig. 1 is a typical application for an instrumentation amplifier. The arrangement of four resistors R_x, R_A, R_B, and R_C is known as a bridge circuit. When the relationship

$$R_x R_C = R_A R_B$$

is true the bridge is said to be balanced and $V_1 = V_2$ and the output of the instrumentation amplifier is zero. The resistor R_x could be a thermistor or strain gage. Its changing resistance provides a voltage at the output of the instrumentation amplifier that is a function of the physical variable being measured.

Use either Cadence or National Instruments SPICE to plot V_o versus R_x as R_x varies from $5\,\mathrm{k}\Omega$ to $15\,\mathrm{k}\Omega$. The values of the circuit components are: $E = 9\,\mathrm{V}$, $R_A = R_B = R_C = R_2 = R_3 = R_4 = R_5 = 10\,\mathrm{k}\Omega$. Assume that the op amps are ideal.

Verify the SPICE solution with a calculation for $R_x = 7.5\,\mathrm{k}\Omega$.

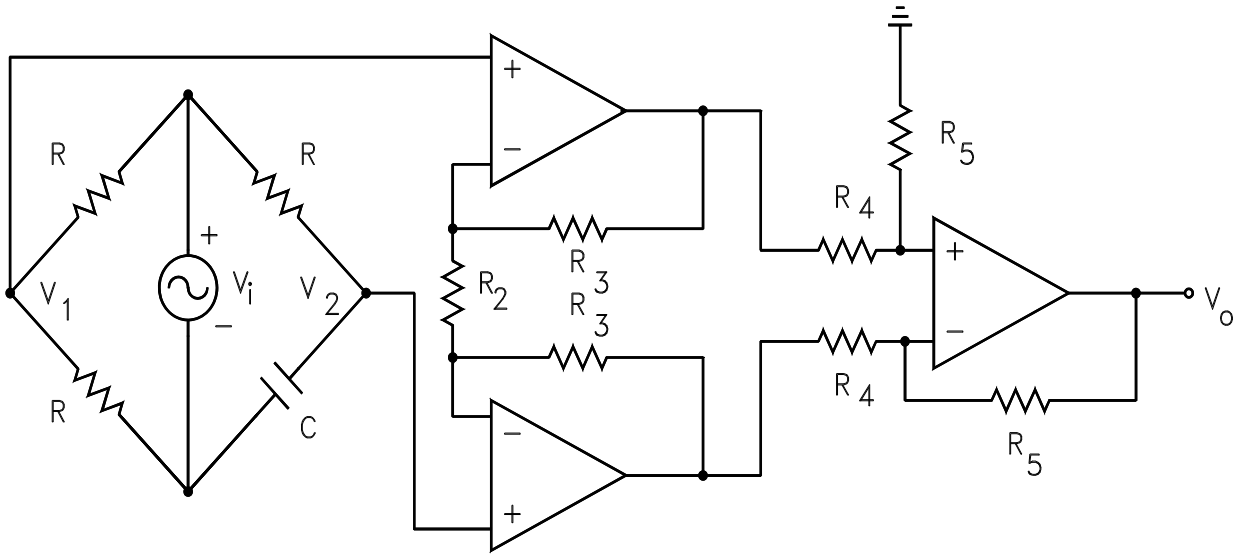

Fig. 2. First Order All Pass Filter

2. Shown in Fig. 2 is a typical application for an instrumentation amplifier. This circuit is a filter known as a first order all pass filter. Design the circuit so that the gain is 6 and the phase shift 90° when $f = 1\,\mathrm{kHz}$. Pick $C = 0.1\,\mu\mathrm{F}$. Pick $R_2 = R_4 = 1\,\mathrm{k}\Omega$. This circuit has a single real pole in the left half plane and a single real zero in the right half of the complex plane.

Plot the magnitude and phase of the complex transfer function $T = V_o/V_i$ as a function of frequency as f varies from $100\,\mathrm{Hz}$ to $10\,\mathrm{kHz}$. Assume that the op amps are real.

Verify the computer analyses at a frequency of $3\,\mathrm{kHz}$ with a hand calculation of the gain and phase.

Also plot the complex transfer function with Mathcad.