OBJECTIVE:

The objective of this laboratory is to experimentally determine the step response, the natural response, and the frequency response of the biquad circuit below. The transfer function, the step response and the natural response of the circuit are obtained with Matlab; the conditions for over damped, under damped, and unstable cases are investigated in the pre-lab. The experimental results are then compared with the Matlab results obtained in the pre-lab.

The biquad circuit to be investigated is shown below.

PRELABORATORY:

(1) Use physical arguments to determine the very high, and very low, frequency behavior of the circuit above; determine the type of filter realized by this biquad. Use physical arguments to determine the initial value and final value for the step response of this circuit.

(2) Use Matlab to determine the transfer function of the biquad circuit. Check that your answers are consistent with your results to (1). Determine the effect of doubling and halving all the impedances in this biquad.

(3) Determine how to pick the resistance values so that the transfer function of the biquad is proportional to the transfer function of a series RLC circuit with an output across one of the circuit elements. Use Matlab
to determine a condition for an over damped circuit, and for an under damped circuit. Simplify your results when \( R_3 = R_4 \). Use the Matlab command `pzmap(n,d)` to verify your result. Determine a condition to insure the circuit has no poles in the right half plane.

(4) Plot the step response of the biquad for an under damped, critically damped, and over damped case. Check that your answers are consistent with your results to (1).

(5) Plot the magnitude and phase of the transfer function of the biquad for an under damped, critically damped, and over damped case.

(6) Find the changes to your solutions to (4) and (5) when all the capacitor values are doubled; and again when they are halved. Discuss your result. (SKIP)

(7) Use Matlab to find the response of this circuit to the input \( u(-t) \); this is referred to as the natural response of the circuit. Use a physical argument to find the initial and final value of the natural response; use this to check your Matlab solution.

**EXPERIMENTAL**

Construct the biquad for an under-damped, critically damped, and over-damped case; use reasonable values for the circuit elements. Measure the square wave response of the biquad in each case; compare your experimental results with the step response and natural response found with Matlab. Measure the frequency response of the biquad in each case. Carefully compare your results with the results obtained from Matlab; discuss your results.