

# Mechatronics I Laboratory Exercise:

## Rotary Position and Velocity Measurement

In this lab, you will investigate several different methods of measuring rotary position and velocity. Two sensors will be used – potentiometer for rotary position and tachometer for angular velocity. You will also use your differentiator circuit to obtain velocity information from the potentiometer.

### Potentiometer

A potentiometer is a simple device. It consists of a strip of conductive wire, plastic, or ceramic across which a voltage is applied. A wiper contacts the conductive material and is moved - typically turned - by a shaft. The wiper electrically creates a voltage divider of the conductive material (see Figure 1).

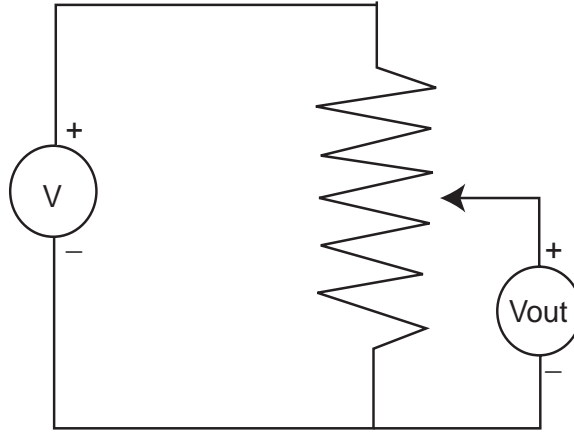


Figure 1: Schematic of a potentiometer.

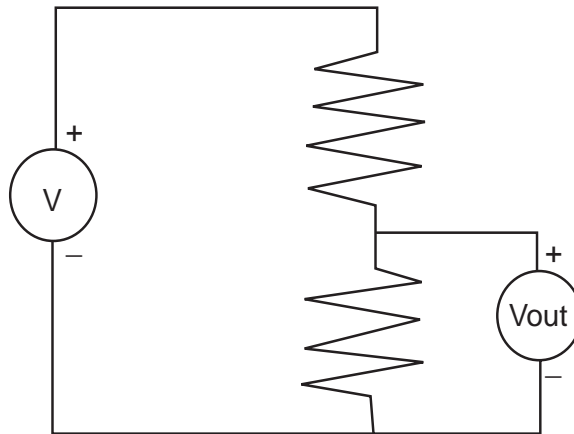


Figure 2: Equivalent circuit of a potentiometer.

### Tachometer

A tachometer is essentially a generator or a motor being run in reverse - meaning the input is mechanical power and the output is electrical power. The details of how motor/generator work will be explored in Mechatronics II. Suffice it for now, however, that the output voltage of the tachometer is a function of the angular velocity.

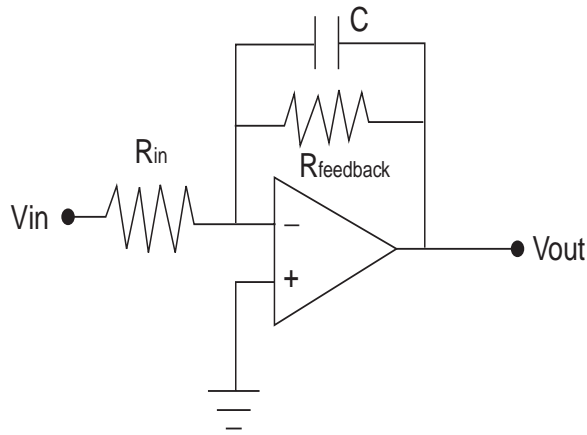


Figure 3: An active low-pass filter.

### Pre-Lab Report

1. Determine the theoretical transfer function of a potentiometer.
2. It is advisable to pass the output from a potentiometer through a voltage follower before using the signal. Explain the use of a voltage follower. Why is it necessary?
3. Find the transfer function of the filter and differentiator circuit (see Figure 3). Use the differentiator circuit from your Op-Amp lab.

### Laboratory Exercise

Equipment Needed: Potentiometer, tachometer, breadboard, function generator, and oscilloscope.

Apply a sinusoidal signal from function generator to the power-amplifier that drives the motor. The pendulum attached to the motor should oscillate.

1. Measure the angular response of the pendulum using the potentiometer. Ensure that you have: (a) buffered the signal from the potentiometer; and (b) scaled the signal appropriately to get the best resolution from the data acquisition card. Start LabWindows CVI and load the project "POT.PRJ" from "C:\CVI\PROGRAMS\LABS\POT" folder. Take the output from your circuit and connect it to **ALCH0** (output signal) on the A/D board. Take the output from the function generator and connect it to **ALCH1** (input signal). Set the appropriate sampling rate and number of samples and start the program. There should be two waveforms captured by CVI, one is the output from your circuit (output signal) and the other is function generator input signal (input signal). Save the file and show the plot in your report. The data file contains three columns. First column is time, second column is output signal, and third column is input signal. What is the amplitude of the signal and what is the phase difference from the input to the motor?
2. Use a differentiator to obtain velocity information from the potentiometer output. Again ensure that you have a filter built into your differentiator. Connect the output from the differentiator to **ALCH0** (output signal) and the function generator signal of **ALCH1** (input signal). Set the appropriate sampling rate and number of samples and start the program. Save the file and include the plot in your report. The data file contains three columns. First column is time, second column is differentiated potentiometer signal, and third column is input signal. What is the amplitude of the velocity signal and the phase difference from the input to the motor?
3. Connect the differentiated signal from the potentiometer to **ALCH0** of the A/D board. Connect the output voltage of the tachometer to **ALCH1** of the A/D board. Set the appropriate sampling rate and number of samples and start the program. Save the file and include the plot in your report. The

data file contains three columns. First column is time, second column is differentiated potentiometer signal, and third column is tachometer voltage signal. Compare the signal from the tachometer with the information provided by differentiating the voltage from the potentiometer.

**Post-Lab Report**

Discuss your observations. How would you find position information using a tachometer?