Introduction to Sensors, Measurement and Instrumentation

Lab 1: Simple Pendulum

Sparsh Gupta

Olin College of Engineering

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Graph of the Pendulum Motion

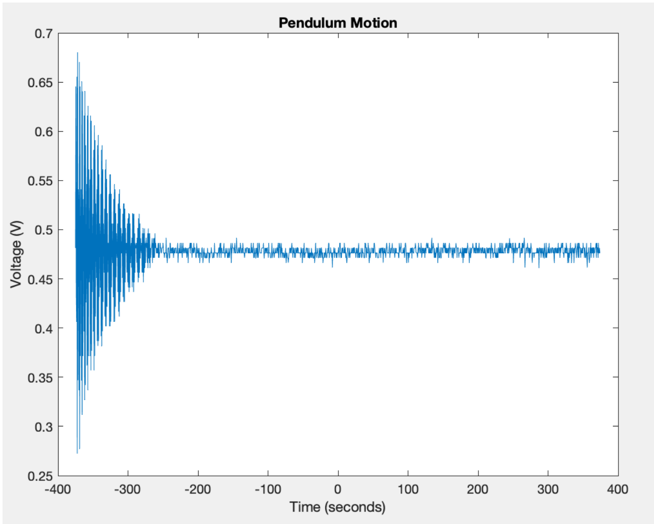

Figure 1: Pendulum Motion Graph (Voltage(V) vs Time(t)) - A 10 kΩ potentiometer was used as an angular position sensor in a voltage divider circuit with 1 V DC input to record the pendulum dynamics.

Calibration Curve for V(θ)

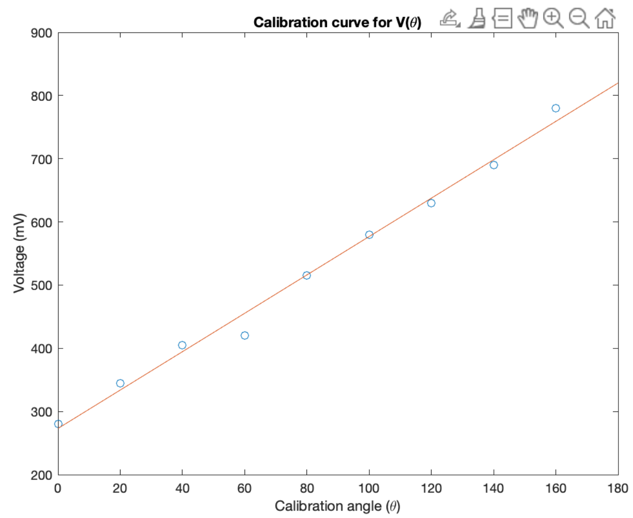

Figure 2: Calibration curve (measured as Angle (θ) vs Circuit output voltage (mV)) - Plotting a best-fit line curve to get a relationship between known θ values and the V_{out}.

Circuit Diagram

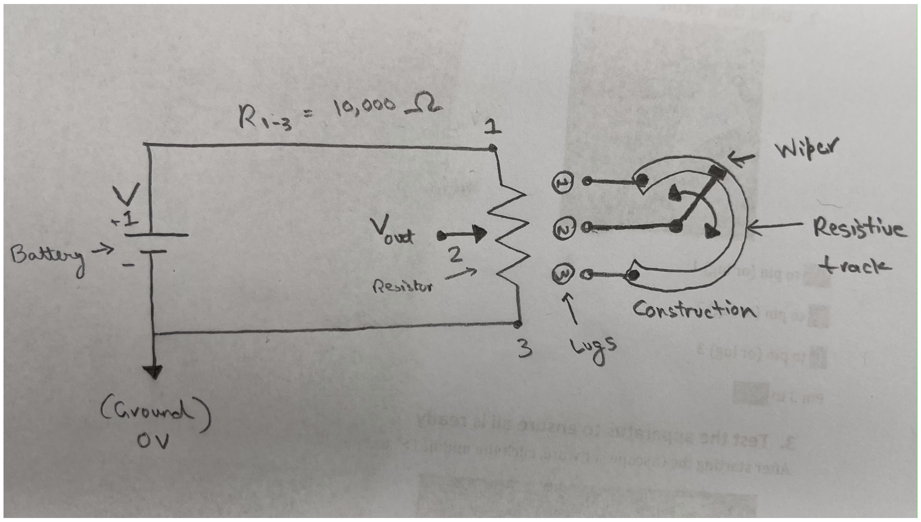

Figure 3: The circuit diagram represents a potentiometer-based resistance-divider circuit to measure pendulum dynamics.

Implementation of Pendulum Motion Graph

```
clear; % clears memory - useful if you run many scripts in the same session
clf;

%take in data from csv file
tname='pendulumcircuit_Lab1.csv'; % <-input your data file's name! test2.csv was exported from O-scope software with a line of headers
datatable  = readtable(tname);%makes data table with headers

%interpret data as times and voltages
time1  = datatable.t1; % stores the t1 column of data in a variable called time1
V1    = datatable.ch1; % stores the ch1 column of data in a variable called V1
time2    = datatable.t2; %stores the t2 column of data in a variable called time2
V2 = datatable.ch2; %stores the ch2 column of data in a variable called V2

%plot (you can change this section to suit your plotting needs!)
plot(time1,V1) %plots first channel
xlabel('Time (seconds)'); % add x axis label
ylabel('Voltage (V)'); % add y axis label
title('Pendulum Motion');
```

Implementation of Calibration Curve for V(θ)

```
% Calibration curve data points V(\theta)

x = [0,20,40,60,80,100,120,140,160]
y = [280, 345, 405, 420, 515, 580, 630, 690, 780]

p = polyfit(x,y,1)

% Plot calibration curve
x1 = linspace(0,180);
y1 = polyval(p,x1);
figure
plot(x,y,'o')
hold on
plot(x1,y1)
hold off
xlabel('Calibration angle (\theta)')
ylabel('Voltage (mV)')
title('Calibration curve for V(\theta)')
```

Transfer Function Equation

$f(x) = 3.0375x + 273.11$
It is a **linear equation** of form y = mx+c

Transfer Function Explanation

The potentiometer circuit consists of a resistive track that basically varies the resistance linearly in the circuit through the motion of the wiper blade. This is done by dividing the total resistance, R_{1-3}, of the potentiometer. Here, the wiper blade motion is controlled by the rotatable pendulum shaft motion (as a function of θ) linearly. So, when the pendulum angle (θ) changes, R_{1-2} changes, i.e., the resistance between lugs 1 and 2. Because the θ varies linearly, the potentiometer changes the voltage in the circuit linearly as well throughout the simulation. Hence, the transfer function is expected to be linear, and the above reasoning proves it.