

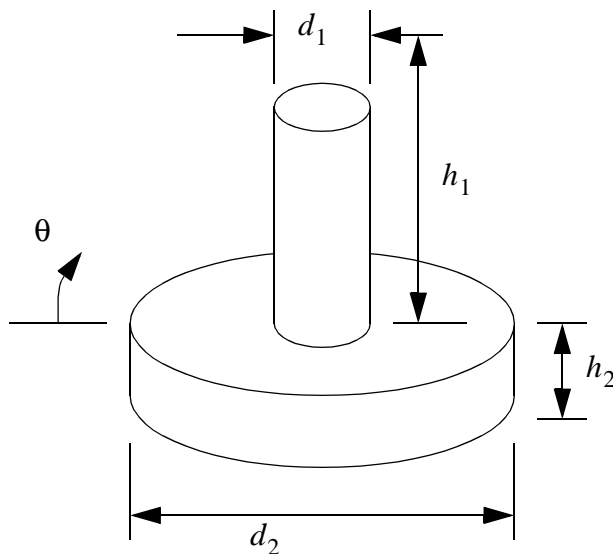
16.0.1 Lab 12 - Torsion

16.0.1.1 - Purpose

To theoretically predict and experimentally verify the period of oscillation for a torsional pendulum.

16.0.1.2 - Background/Theory

Suppose a large symmetric rotating mass has a rotational inertia J , and a twisting rod has a torsional spring coefficient K . Recall the basic torsional relationships.



$$\sum T = -\left(\frac{J_A G}{L}\right)\theta = J_M \left(\frac{d}{dt}\right)^2 \theta$$

Figure 16.1 A torsional mass

16.0.1.3 - Prelab

1. Calculate the explicit equation for the natural frequency for a rotating mass with a torsional spring by solving the differential equation.
2. Set up a Scilab program that will include the following elements. Please note that units are very important. You are strongly encouraged to use metric units to minimize calculation problems.
 - use material properties and a diameter of a round shaft and determine the spring coefficient.
 - accept geometry for a rectangular mass and calculate the polar moment of inertia.
 - use the spring coefficient and polar moment of inertia to estimate the natural frequency.

- plot the function derived using the explicit solution.
- use previous values to estimate the oscillations using Runge-Kutta integration and plot the results.

3. Write a Labview program that will read analog input data and save it to a file.

4. Review the Experimental Procedure.

16.0.1.4 - Equipment

A computer with Labview and a DAQ card
The machine shop and appropriate equipment
A potentiometer
A power supply
Force Gauge

16.0.1.5 - Experimental Procedure

1. Design and build a large torsional pendulum. The design elements below should be considered.
 - The pendulum will normally be suspended from the unistrut on the ceiling of the laboratory. It will need to be firmly clamped.
 - Select a round rod for the spring. A longer length, and a diameter from 1/4" to 1/2" will give a reasonable frequency range. Make sure you can identify the material so that you can estimate the spring coefficient.
 - Select a mass of 10-20kg. Ideally the mass will have a simple geometry that will simplify the calculation of the moment of inertia. Placing parts of the mass farther from the center of rotation will lower the frequency.
 - A potentiometer should be mounted at the center of rotation to measure position.
2. Collect values from the physical equipment and use these to calculate the frequency of oscillation.
3. Calibrate the potentiometer so that the relationship between the output voltage and angle is known. Plot this on a graph and verify that it is linear before connecting it to the mass. Calculate the relationship between input angle and output voltage. Use this in following steps to convert potentiometer voltages to angles.
4. Verify that values displayed in Labview correlate to the position of the potentiometer and the time.
5. Connect the potentiometer to the mass. Apply a static torque and measure the deflected position. Use this to calculate a coefficient for the torsional spring.

6. Apply a torque to offset the mass, and release it so that it oscillates. Estimate the natural frequency by counting cycles over a long period of time. Compare this to the theoretical value.
7. Determine if the initial angle of deflection changes the frequency of oscillation.