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## Lab Report: Simple Gyroscope

EN200: Applied Mechanics Lab
Simple Gyroscope
The earth is an example of a naturally occurring gyroscope. Items that are produce such as tops, flywheels, footballs and navigational gyroscopes are also gyroscopes. The feature they have in common is a rigid body that spins in a symmetrical axis with a larger angular velocity of spin. There are two general categories of gyroscopes mechanical and optical. (Morse 30) A mechanical gyroscope was studied in this lab. A mechanical gyroscope is used to maintain orientation or to measure orientation. The reason experiments are so important is because the amount of even a tiny error causes a larger error in the measurement of the angular momentum (Morse 31). Modern technology for navigation system, like robots and satellites, need measurements that are reliable. The industries that use gyroscopes range from medical applications, automotive, outer space and military applications. (Armenise et al. i)

## Aims and Objective

The aim of this experiment was to better understand how a gyroscope works by observing the behavior of a gyroscope.
Objectives
Methodology and Theory
The methodology was qualitative because the experiment was hands-on. The quantitative because measurements were taken and then, evaluated by the following theoretical equation. The equation applies when the assumption that a right-hand coordinate set is formed between the spin, precession and moment axis.
M= IωΩ
M (Nm) = Moment applied to gyroscope
I (kgm2) = Moment of inertia to gyroscope flywheel
ω (rad/s) = Rotational spin of gyroscope flywheel
Ω (rad/s) = Rotational precession of gyroscope flywheel
Moment is the Precession can be defined as the how much the rotational axis orientation changes in reference to the rotation axis of the gyroscope flywheel. Application of torque (force) to the system causes wobbling, like when a spinning top wobbles for some time before it stops. A cone shaped axis results when the rotation speed and the torque magnitude are constant. The movement of the gyroscope fly wheel under those conditions is at a 90° angle to the torque being applied. The gyroscope used for the experiment had one fixed point so that the sphere’s center point maintains its position in space. Since the equation can also be written as I = MωΩ, I can be found by measuring M, ω, and Ω.

## Apparatus

The experiment was carried out using an apparatus with a steel flywheel and a high speed motor mounted in the heat unit which can pivot and rotate freely. The scale of the apparatus measures the external moment when a weight is clamped into place along an arm. The control unit in the base drives the flywheel. RPM (Ω as RPM x 100) can be read from the display. The RPM measurement is of the motion of the spindle.
The ‘ hands-on’ part of the experiment included putting the precession drive belt around the drive pulley when needed. Caution needed to be taken when adjusting the speed; it needed to be done slowly because of the belt is large enough to be placed on the precession drive. Increasing the speed to quickly would cause the belt to slip off the drive. The disk on the arm of the apparatus is the moment weight. The purpose of this design is to make sure that too much load cannot be placed on the bearings and motor. The motor speed should not be increased too quickly and it should not be too fast. The Gyro arm impact was another feature that could potentially cause a hazard. In order to calibrate the readings to zero, a measurement was taken when the weight was its point of initial balance.

## Results: Tables and Graphs

Gyroscope Lab Measurements
The constant is equal to 56727. (see fig. 1)
Figure Graph to find the Constant = y (the slope)
The average or mean of the rotor inertia is equal to 0. 003976 (3. 976 x 10-3).
The median rotor inertia is 3. 91 x 10-3.
When p = 7850 kg/m3 for steel and the radius = 111mm/2, the equation IDISC = πr4hp/2 can be solved for h. (see table 2) The rotor inertia was measured in the experiment.
IDISC = πr4hp/2 when p = 7850 kg/m3 for steel and π = 3. 142, r4 = 44. 5 mm4, h = 0. 035 mm then IDisc =

## Discussion

IDISC = πr4hp/2 when p – 7850 kg/m3 for steel

## Conclusions

1. With a configuration with 20 N moment weight the rotor speed decrease when the rotor inertia decreases. They are inversely proportional.
2. With a configuration with 111mm of distance from balance position, the Precession Speed increases when the rotor inertia increases. They are directly proportional.

## References

Armenise, Mario N., Ciminelli, Caterina, Dell’Olio, Francesco and Vittorio M. N. Passaro. Advances in Gyroscope Technologies. Heidelberg: Springer-Verlag Berlin. 2010.
Morse A. S. “ Heading Sensors.” Chapt. 2. Where am I? Sensors and Methods for Mobile Robot Positioning, Edited and compiled by J. Borenstein, Prepared for UMich. for Oak Ridge National Lab D&D Program and the U. S. Depart of Energy, 1996, pp. 30-64. n. d. Web. 2014 May 12.