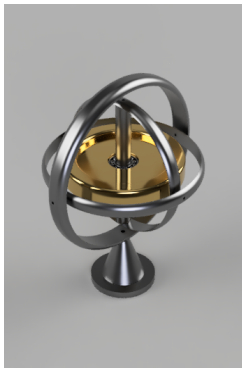
TA201P - Group 8 S2

TABLETOP GYROSCOPE
PROJECT REPORT



TA201A: Introduction of Manufacturing Processes-I
Engineering Metallurgy Lab

Project Title: Tabletop Gyroscope

Group Number: Group 8 S2

Group members:

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Lab-in-charge: Mr Anil Kumar Verma
Course-in-charge: Mr Indra Pal Singh
Tutor: Mr Harish Ranot

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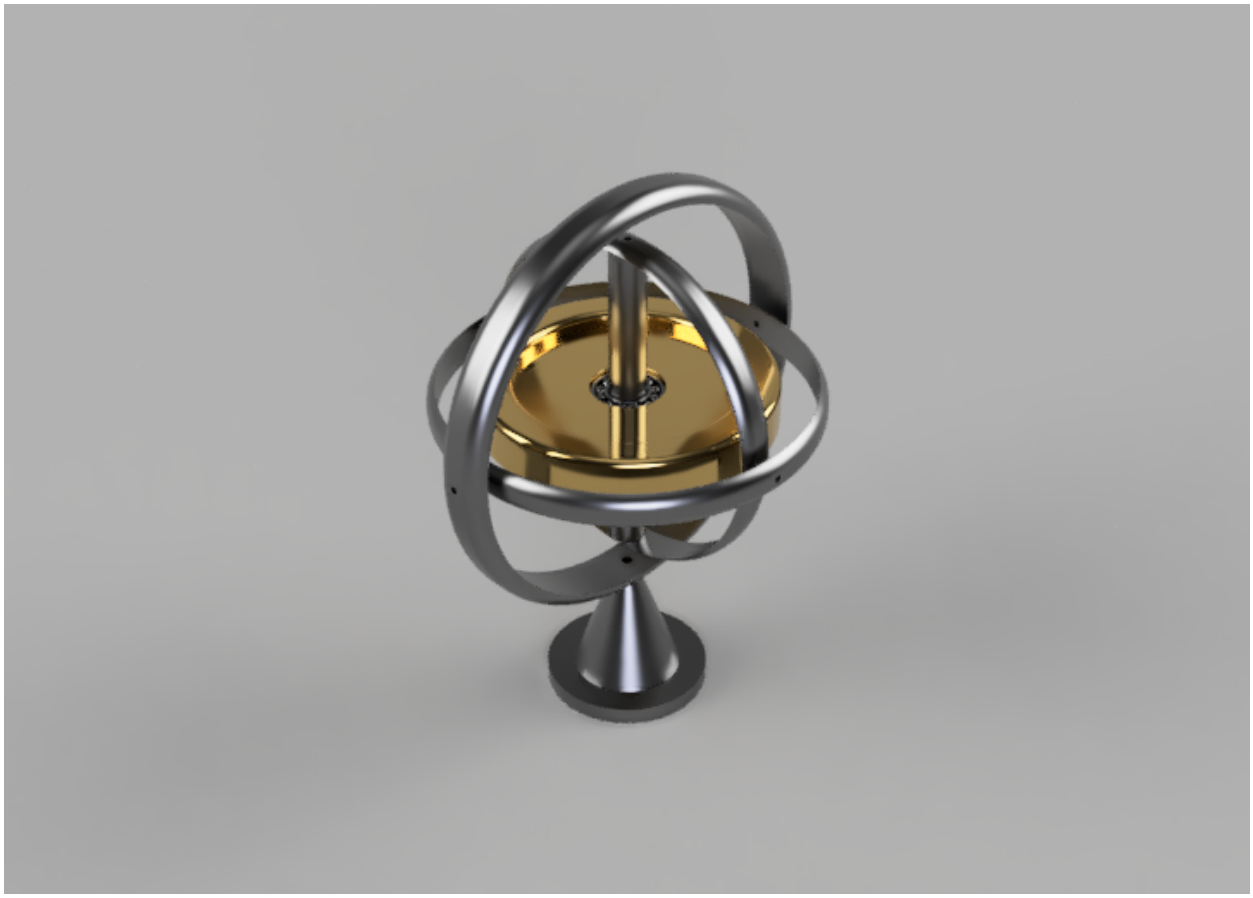


1. Introduction

A gyroscope is a device used for measuring or maintaining orientation and angular velocity. The orientation of the spin axis is not affected by the tilting of the mounting, according to the conservation of angular momentum. This provides the object stability as it tends to not deviate from its axis of rotation.

The first known apparatus similar to a gyroscope was invented by John Serson in 1743. It was used as a level, to locate the horizon in foggy or misty conditions.

Applications of Gyroscopes

- Aircraft to monitor and control the orientation of the aircraft in flight.
- Cruise and ballistic missiles use gyroscopes to keep track of orientation.
- Gyroscopes allow orbital spacecraft to keep track of orientation in a highly accurate way to determine movement in a 3D space.
- Modern smartphones allow for a highly accurate way to determine movement in a 3D space.
- Gyroscopes are used in gyrotheodolite to maintain direction in tunnel mining.

For potential future uses, work on Gyroscopic Public Transportation is in progress.

2. Motivation

A gyroscope is an instrument that has appeared in a number of courses to explain either the conservation of angular momentum or its applications. It is a simple instrument based on a very familiar physics law with some fascinating applications.

So, while discussing project ideas it evidently came up and we included it in the “3 ideas”. It can be made in the TA201 lab since it is small and made up of raw materials and manufacturing processes available in the

lab. So, considering the above we took the gyroscope as our group project.

While making different components of the gyroscope we will apply various manufacturing processes we learned of in TA201T.

3. Acknowledgements

We would like to thank our instructor, *Dr Anish Upadhyaya* for giving us this opportunity to work on this project. Furthermore we would like to thank our Tutor, *Mr Harish Ranot*, and *Mr Anil Kumar Verma* for their continuous support and guidance, without whom this project would not have been realized. We would also like to thank *Mr Indra Pal Singh* for making the live lecture demonstration videos which motivated us to work on this project, despite the difficult times.

4. Work Distribution

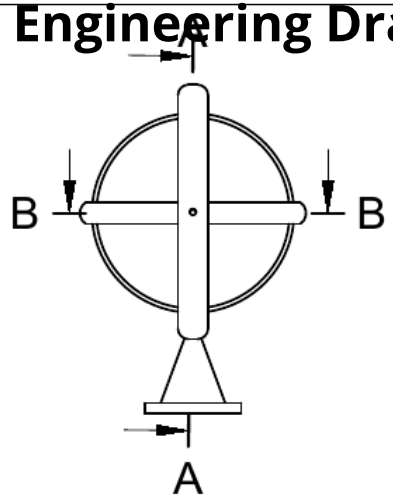
Name	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7
Diwakar	Idea 3	Planning	Introduction	References	Introduction and Motivation	PPT Making	Video Recording and Scripting
Debaditya	Idea 1	Documentation	Compilation	Compilation	Compilation Documentation	PPT Making	Video Recording and Scripting
Gopi K		Planning	Cost Analysis	Cost Analysis update	Details of disassembled pieces	PPT Making	Video Recording and Scripting
Chiranjit		Planning	Materials	Materials update	Observation Discussion	PPT Making	Video Recording and Scripting
Banoth		Planning	Sustainability	Sustainability	Sustainability	PPT Making	Video Recording and Scripting
Dhruvil	Idea 2	Planning	Manufacturing process	Manufacturing	Error checking, Salient features	PPT Making	Video Recording and Scripting
Harishankar		Drawings	Drawings	Drawings update	Drawings	PPT Making	Video Recording and Scripting
Dhananjay			Manufacturing process	Manufacturing process	Acknowledgements	PPT Making	Video Recording and Scripting
Surya			Exec summary	Exec summary	Summary	PPT Making	Video Recording and Scripting

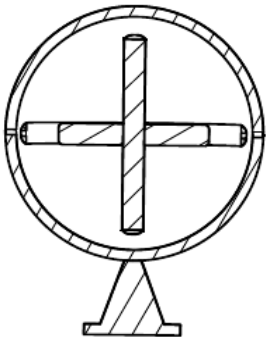
Note: Week 5 Referrers to work done for part A of the project.

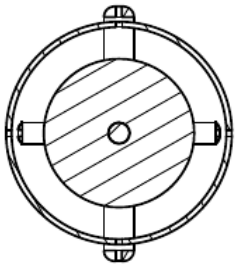
5. Material List and Manufacturing Processes

Sr No.	Part Name	Material Required	Quantity	Process used
1	Rotor	Mild Steel Disc 70mm diameter 10mm thickness	1	1) Centre drilling for the rod. 2) Tungsten Inert Gas (TIG) Welding is used to join the rod to the rotor
2	Rod	Mild Steel Rod 10 mm Diameter Length 90mm	1	1) Drilling pin slots on each end. 2 TIG Welding rod to hole in the rotor to permanently fix the rod.
3	Inner Gimbal	Mild steel sheet 282mm 4x2x8mm	1	1) Metal sheet cutting to required dimensions.. 2) Ring rolling to get into circular shape 3) TIG Welding edges. 4) Finishing by grinding and buffing.
4	Middle Gimbal	Mild steel sheet 282mm 4x2x8mm	1	1) Metal sheet cutting to required dimensions.. 2) Ring rolling to get into circular shape 3) TIG Welding edges. 4) Finishing by grinding and buffing.
5	Outer Gimbal	Mild steel sheet 282mm 4x2x8mm	1	1) Metal sheet cutting to required dimensions.. 2) Ring rolling to get into circular shape 3) TIG Welding edges. 4) Finishing by grinding and buffing.
6	Base	Cast Iron	1	1) Lost foam casting using molasses sand. 2) Finishing by grinding and buffing.
7	Pins	Steel Rod	6	1) Cutting steel rod. 2) Hammering to make rivets.
8	Thermocol	Thermocol	1	1) Mould making for lost foam casting

6. Engineering Drawings







6.1. Assembly Drawing

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		S2 - Group 8 04-Jul-21	
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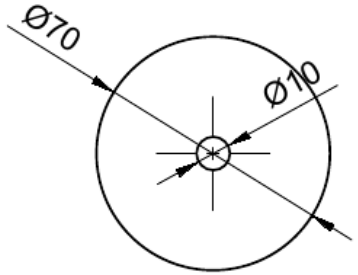
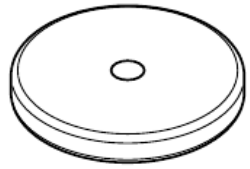
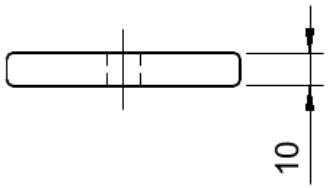
6.2. Rotor







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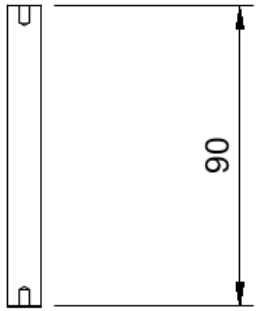
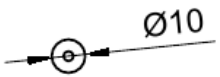
6.3. Rod





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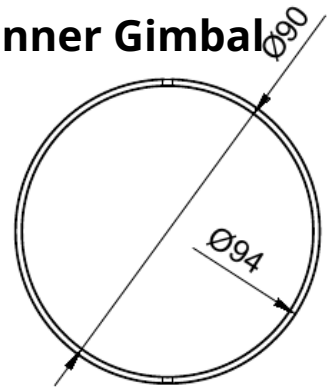
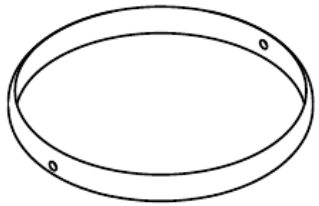
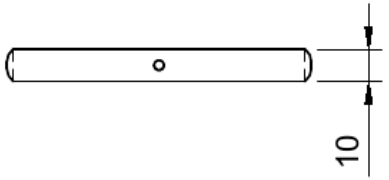
6.4. Inner Gimbal







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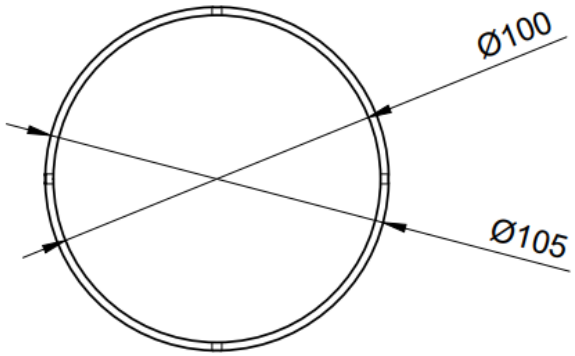
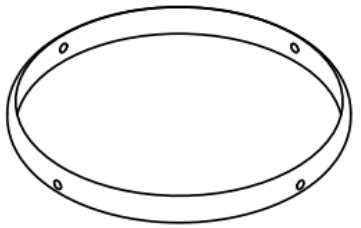
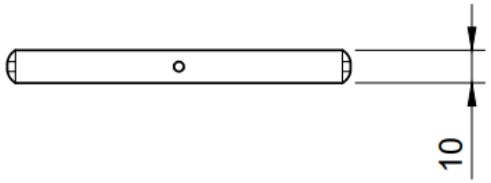
6.5. Middle Gimbal







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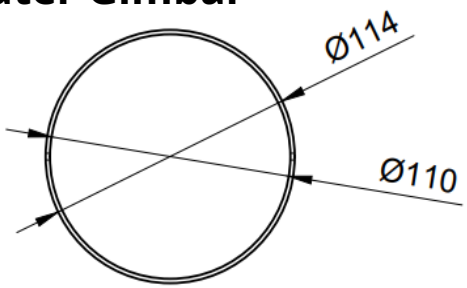
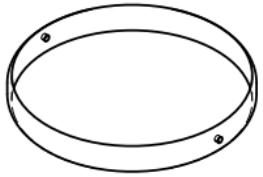
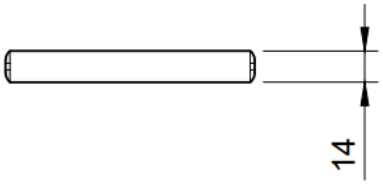
6.6. Outer Gimbal







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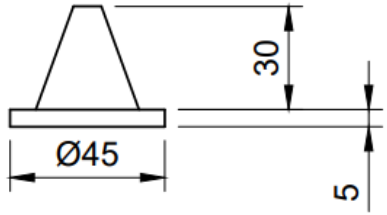
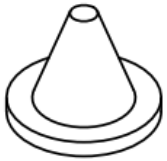
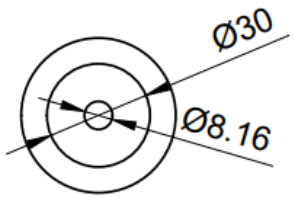
6.7. Base







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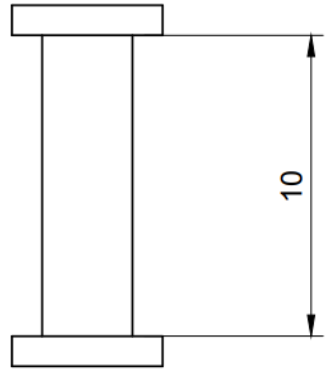
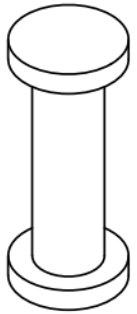
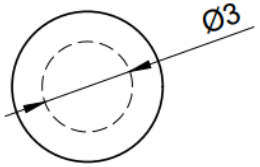
6.8. Pins







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7 Cost Analysis

Density of materials:

- Mild Steel: 7850 kg/m^3
- Cast iron (to be melted): 7300kg/m^3

Prices:

Mild steel rod - 10mm D: Rs. 68 / kg
Mild steel rod - 3mm D: Rs. 80 / kg
Cast iron: Rs. 75 / kg

Parts:

- Rotor (Mild steel disk)
  - Mild steel disk - 70mm D, 10mm W: ***Rs. 20/-***
- Rod (Mild steel)
  - Total volume & weight: 7068.5835 mm^3 0.0555 kg
  - Mild steel rod - 10mm D, 90mm L: ***Rs. 3.77/-***
- Base (Cast iron)
  - Volume and weight of truncated cone: 9514.2 mm^3 0.06945 kg
  - Cost of cone + disk ***Rs. 30.21/- = Rs. 5.21/- + Rs. 25/-***
- Pin (Mild steel rod 3mm D)
  - Cost of 6 pins ***Rs: 0.27/-***
- Inner Gimbal
  - Total volume: 5723.98 mm^3
  - Mild steel sheet (90-95mm D): ***Rs. 2.97/-***
- Middle Gimbal
  - Total volume: 7979.645 mm^3
  - Mild steel sheet (100-105mm D): ***Rs. 8.34/-***
- Outer Gimbal
  - Total volume: 8835.730 mm^3
  - Mild steel sheet (110 - 115 mm D): ***Rs 10.25/-***
- Thermocol, fevicol, other misc
  - Total cost: ***Rs. 50/-***
- Manufacturing costs:
  - Skilled Labor ***Rs. 45/-***
  - Unskilled Labor ***Rs. 55/-***

Net total:

- Material cost: ***Rs. 175.83/-***
- Manufacturing cost: ***Rs. 100/-***
- Buffer: ***Rs. 25/-***

Grand total estimate: **Rs. 300/-**

8. Sustainability

The parts are made of raw material which can be sourced from recycled or repurposed material. This is typical for aluminum and cast iron which can be easily recycled from old material such as previous projects.

When it comes to reusability of our product, the riser and runner that arises due to the casting process can be reused in future casts. After cutting. In Fact since each of the parts is manufactured without invasive measures the entire product can be recycled with ease, if the need arises.

During invasive procedures such as drilling, it is advisable to perform it slowly to ensure that chips are not burnt. These chips can be recycled by melting and casting. The same goes with sheet cutting which can be done slowly and carefully to ensure wastage is minimum. The waste sheets can be recycled by melting and casting. The pins can also be precision cut and hammered to ensure no wastage.

Large scale production of this can be attained with minimum wastage, as per the recycling process above. Thermocol mould can be replaced with wood mould in large-scale production.

9. Executive Summary

Gyroscope is a device used for measuring and maintaining orientation and angular velocity. It is a spinning disc in which the axis of rotation is free to assume any orientation by itself. The principle behind a gyroscope is conservation of angular momentum.

Gyroscopes have many applications, they are used in submarines and telescopes to maintain orientation. They are also used in space launch vehicles, ballistic missiles and orbiting satellites. We decided to manufacture Gyroscope as it is one of the most important devices used in many fields.

The gyroscope is made of 3 gimbals which are pivoted supports that permit rotation, a gyro wheel or disc which is at the centre, a rod which acts as a spin axis and a base that supports the structure. For the gyro disc or rotor we used a mild steel disc of 70 mm diameter. For the rod we used a mild steel rod of 10 mm diameter and 90 mm length. A hole of 10 mm is made at the centre of the rotor by drilling and the rod is passed through this hole and welded to permanently fix it.

For the three inner, middle and outer gimbals we used a mild steel sheet. We cut the mild steel sheet to required dimensions respective

to each gimbal. Then we used ring rolling to get the sheet into a circular shape and welded the edges. Then we finished it by grinding and buffing. The base is made from cast iron through lost foam casting using molasses sand and finished by grinding and buffing. We used thermocol for mould making.

We made holes to the gimbals using drilling. Then we passed pins which are cut from a steel rod through these holes through a pair of gimbals and hammered them to make rivets. Then we welded the base to the outer gimbal to complete the gyroscope.

Finally we performed a cost analysis and prepared a sustainability report and compiled all our work into this project report, finishing off the **Tabletop Gyroscope.**

10. References

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