DESIGN REPORT

Team Xtreme squad

MVJ College of Engineering

➢ ABSTRACT

This report documents the process and methodology to produce a low-cost go-kart which is light weight, easily driven, durable as well cost friendly and complete in all aspects by modelling it with solidworks software. The team focuses on a technically sound vehicle which is backed by a profound design and good manufacturing practices.

This paper represents the designing and failure criterion according to the von-Mises stress for four different materials. The objective of present investigation aims to get perfect material for the designed chassis and enhance the value of factor of safety for low ground clearance Go-Kart. For the safety point of view of the driver present analysis is carried out for a range of force values for all three-impact test

➢ INTRODUCTION

The Go-Kart has been designed and manufactured by Team XTREME SQUAD consisting of undergraduates from MVJ College of Engineering (autonomous institute). Prof. Sandeep S, (Mechanical department) provided us valuable support as the faculty advisor for the project. The Team has undertaken extensive research to find better suited alternatives, increase endurance and make a race-ready kart.

The go-kart will be built from the ground up to maximize the efficient use of space, and to ensure that the needs of the client are met. We approached our design by considering all possible alternatives for a system & modelling them in CAD software like solidworks 2022 and subjected to analysis using ANSYS WORKBENCH 2021 R2 software. Based on analysis result, the model was modified and retested, and a final design was frozen.

1 TECHNICAL SPECIFICATION OF KART

ENGINE – TABLE 1

Engine	Hero Hunk 150
Displacement	149.2 cc
Power	11.64 KW @8500 rpm
Torque	13.5 Nm @7000 rpm

KART PERFORMANCE – TABLE 2

Maximum Acceleration	14.42 m/s^2
Top Speed	95 kmph
Fuel economy	50 kmpl

CHASSIS – TABLE 3

Weight (with mounts)	14.9 kg
Wheelbase	1020 mm
Trackwidth(rear)	1040 mm
Trackwidth(front)	960 mm
Centre of gravity	18 mm (from the ground, chassis alone)

KART DIMENSIONS – TABLE 4

Length	1820 mm
Breadth	1200 mm
Height (excluding driver)	566 mm
Ground clearance	35 mm
Centre of gravity	260 mm from the ground

STEERING – TABLE 5

Steer effort	38.64 N
Minimum turning radius	1779.08 mm
Maximum turning radius	2440.97 mm
Inclination of steering column	60^0

TRANSMISSION – TABLE 6

Gear shifting mechanism	Push pull rod mechanism
Train value / reduction (Primary)	3.3500 (67/20)

BRAKES – TABLE 7

Master cylinder	15.19 mm diameter
Brake calliper (Bajaj pulsar)	27.44 mm diameter dual piston
Brake disc	190 mm diameter
Brake pedal	Pedal ratio - 5:1
Maximum braking torque generated	238.73 Nm

➢ 3-D VIEW OF THE KART

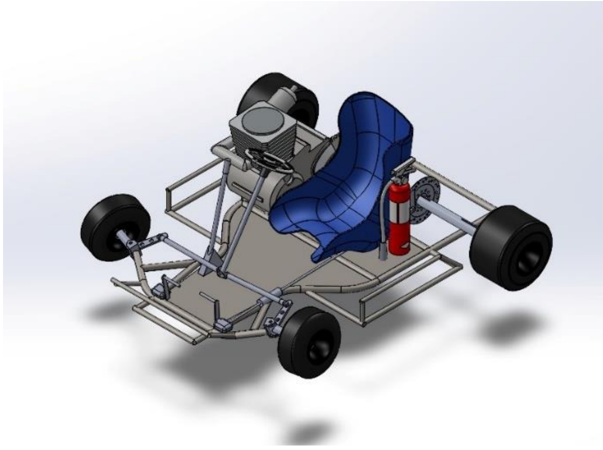

FIGURE 1 ISOMETRIC VIEW 1

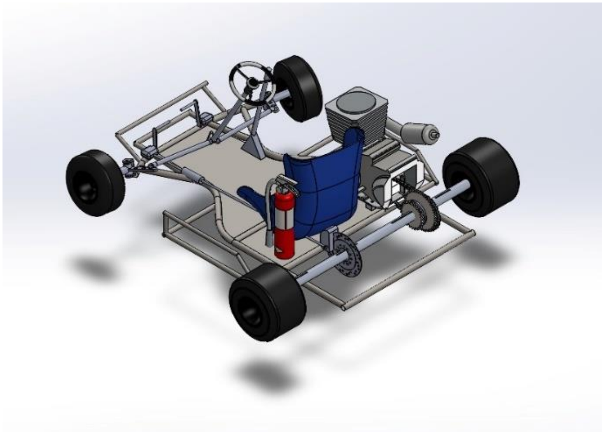

FIGURE 2 ISOMETRIC VIEW 2

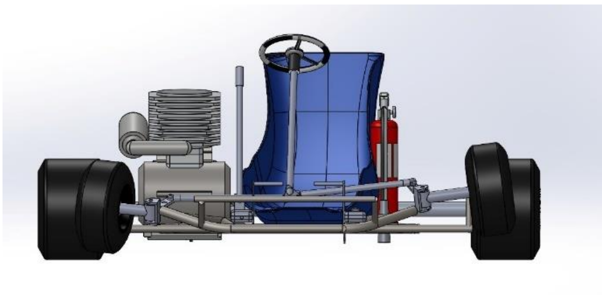

FIGURE 3 FRONT VIEW

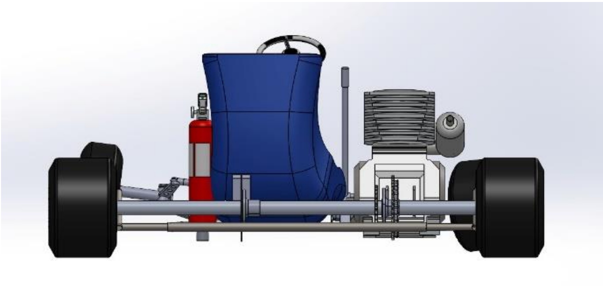

FIGURE 4 REAR VIEW

FIGURE 5 SIDE VIEW

➢ DESIGN METHODOLOGY

The following design methodology was used during design:

- Requirements
- Design calculations and Analysis
- Considerations
- Testing
- Acceptance
- Easy operation.
- Lightweight and compact.
- High reliability.
- Good serviceability.
- Low cost.
- Ease of manufacturing.
- Optimum Braking
- Effortless Steering
- Aesthetically Pleasing

Design objectives

- ❖ Each component must be properly designed, analysed, and optimized before manufacturing and prototyping.
- ❖ All forces and loads must be considered while analysing the CAD geometry.
- ❖ Most precise meshing should be used in order to get most accurate results

Steering Column Inclination and Steering Wheel

Mechanical arrangement is planned to be used the shown type of steering system was selected because of its simple working mechanism and a steering ratio of 1:1 so to simple we have used mechanical type linkage.

The steering wheel was made of rubber for better grip and comfort.

FIGURE 6 STEERING WHEEL AND COLUMN

Gear Shifter + Clutch Mechanism

An efficient gear shifting mechanism was placed towards the right with respect to the driver and the height of the knob was adjusted in such a way that it was in level with the steering wheel, within the reach of the driver. This was done in order to minimize shift timings while driving.

Knuckle

The steering arm of the knuckle was innovatively designed to provide three different points of attachment for the tierod. This allows us to change the effective steer effort according to the requirement of the driver in each respective event to improve handling. The knuckle parameters were set to maintain a steer effort that was neither too much nor too less.

FIGURE 7 STEERING KNUCKLE

Chassis

The distance between the pedals and seat was decided to allow maximum comfort to the driver and to allow maximum effect in applying effort on the respective pedals.

Sufficient spacing was maintained to allow free movement to the driver while driving without clashes with any other component.

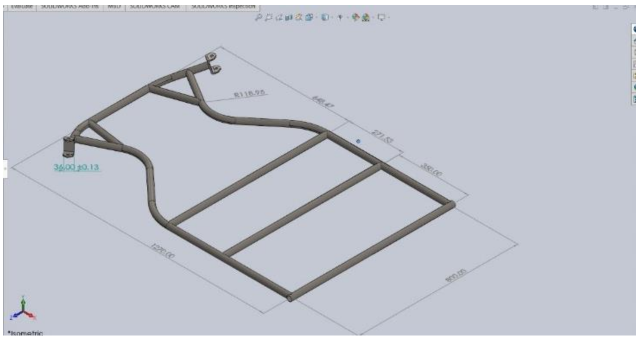

FIGURE 8 ISO VIEW OF CHASSIS

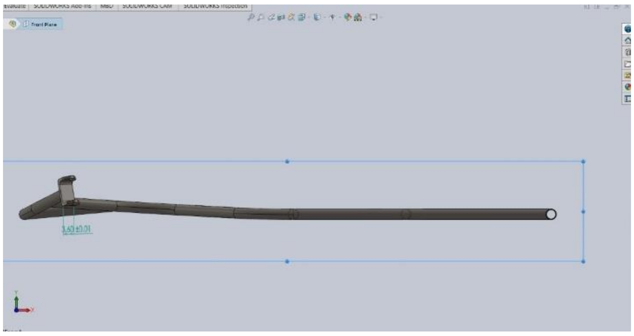

FIGURE 9 FRONT VIEW OF CHASSIS

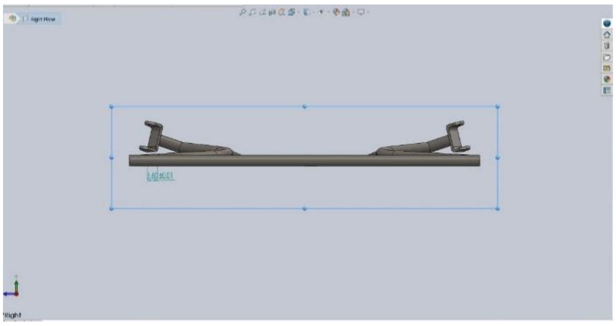

FIGURE 10 RIGHT SIDE VIEW OF CHASSIS

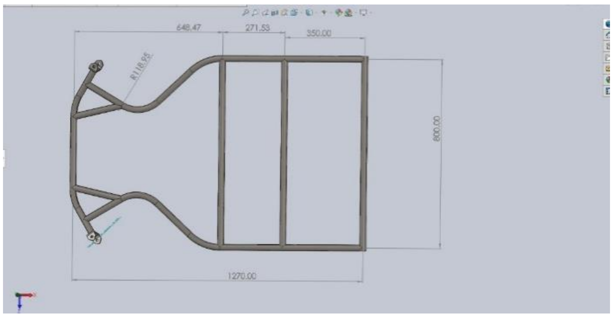

FIGURE 11 TOP VIEW OF CHASSIS

Floor planning

A basic chassis frame of circular pipes of 1-inch diameter and 1.6 mm thickness was designed and selected by taking the points of strength, availability, and cost into consideration.

AISI 1020 was rejected because of its high cost. Previously AISI 1018 was used. It was upgraded to 4130 also known as chrome moly steel is far stronger than 1018. And it also has better ultimate and yield tensile strength over 1018. That allows thinner cross sections for a given tensile load. Therefor lighter construction. Therefore, the material that the team chose to use is AISI 4130.

We used pipes of various cross-sections and thickness as follows:

- Round pipes

Outer diameter	Thickness
25.4 mm	1.6 mm
17.78 mm	2.5 mm

TABLE 8 CHASSIS AND MOUNT ROD DIMENSIONS

➢ DESIGN DECISION

The chassis has been designed by taking factors like dimensional limits (width, height, length, and weight), operational restrictions, regulatory issues, contractual requirements, financial constraints, and human ergonomics as a priority.

The 1st primary safety standard focused on during design was maintaining the proper clearance of the driver's body rest to the other rigid parts like engine compartment, firewall structure, and panel bracing of the vehicle. Once the basic requirements fulfilled the other safety design were implemented. The chassis was designed to give occupant extra space to operate the vehicle easily. The place of the fire extinguisher is designed in the easily accessible point.

Precision Techniques:

We used cutting edge technique like tig welding, Lathe work, cutting, sanding, knurling, drilling, milling, shaping, broaching, grinding, polishing, finishing, for the purpose of fabrication.

Weight Optimization:

Weight of chassis along with the mounts is 14.9 kg. Detailed analysis and simulation coupled with a wise material selection helped in weight optimization.

Finite Element Analysis

The aim is to carry out a design check of the given Go-kart chassis underestimated loading conditions and to minimize the weight of the frame keeping Highest Possible Safety Factor.

Front impact	1.617
Rear impact	1.965
Side impact	3.055

TABLE 9 FACTOR OF SAFETY

The design of the chassis for the Go-kart helps to in finding the strength weakness of the design fabrication.

➢ STEERING SYSTEM

Four bar linkage mechanism which consist of following steering component which were designed in CAD software like solidworks 2022 and subjected to analysis using ANSYS 22R software.

Steering components

Components	Dimensions
Tie rods	716mm
King-pin	10°
Steering column	120mm
Steering wheel	140 mm
Tripod to steering column radius	100 mm

TABLE 10 STEERING COMPONENTS DETAILS

The steering wheel is bolted on the steering column using a mild steel disc to prevent the shearing of the carbon fibre.

FIGURE 12 STEERING SYSTEM

Ackerman Angle

Ackerman Angle	Turning Radius of kart
20.136°	2101.74 mm

TABLE 11 ACKERMAN DETAILS

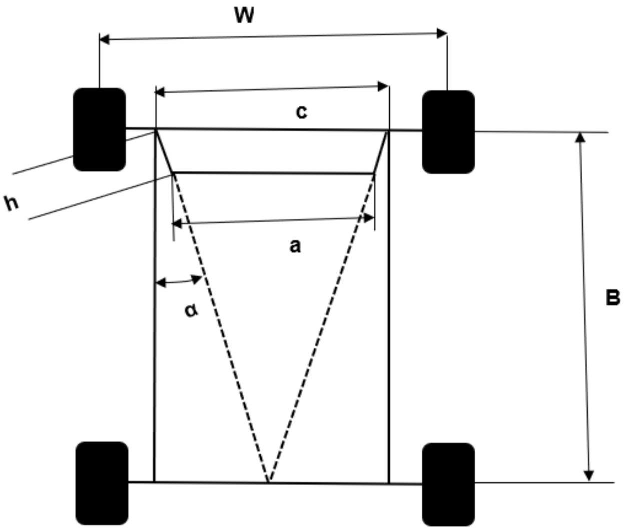

FIGURE 13 ACKERMAN ANGLE AND STEERING PARAMETERS

Our steering geometry is having 100% Ackerman and gives 60degree lock to lock turn of steering wheel which is very suitable for the racetrack as it allows quick turns with a small input and being more precise at the same time. We also attain a perspective turning radius of 2.1meter.

Stub axle

The steering arm and the tie rods are maintained parallel to the ground in the straight-ahead position of the kart. This arrangement helps reduce play in the system.

FIGURE 14 STUB AXLE

Material	Plain Carbon Steel
FOS	1.5

TABLE 12 STUB AXLE PROPERTIES

➢ TYRES

We're using go kart tyres having the dimensions 10 inches for the front wheel and 11 inches for the rear wheel.

Diameter	Slicks	Wets
	BKT	Supertrak
Front	10 inches	10 inches
Rear	11 inches	11 inches

TABLE 13 TYRES

According to the Ackermann geometry the front tyres will rotate about the mean point as a result the entire force will act on the outer front tyre on a corner. Thus, the cornering traction will be primarily governed by the outer tyre.

Wheel Alignment

CONSIDERATIONS FOR STEERING SELECTION

- Amount of steering wheel travelling is decreased
- It is simple and cheap

Camber

Effects:

- During cornering negative camber helps in efficient tire contact patch thereby reducing wear and tear-out of tires.
- Positive camber is used in heavy weight vehicles to achieve efficient contact patch of tires.

Our selection - 0^0, Negative Camber

- Zero-degree camber helps efficient tire contact patch during straight line.
- Negative camber for cornering during events like autocross, endurance.

Caster

Effects:

- Positive caster helps to achieve jacking effect during cornering, straight line stability and produces self-aligning torque on the front wheels and improves vehicle handling.
- Negative caster results in lighter and easier steering but reduced stability during straight line.

Our selection – 8^0 (Positive)

- Straight line stability with optimum steering effort.
- Optimum jacking effect during cornering.
- Self-centring action.

King-pin Inclination

Effects:

- More the Kingpin inclination more is the jacking effect.
- It reduces the scrub radius.
- Returnability increases with increase in kingpin angle.

Our selection – 10^0

- Scrub radius = 0.077 m
- For optimum jacking effect and steering effort
- Self-centring torque.
- Returnability.

Toe

Effects:

- Toe-in increases straight-line stability and it will decrease cornering stability.
- Toe-out decreases the straight-line stability and increases the cornering stability.

Our selection: Based on the events it is adjusted using tie-rods.

- Toe-out for endurance based on the track and for autocross event so that cornering stability is achieved.
- Toe-in for acceleration and brake-test event for straight-line stability.

GEOMETRY	VALUES
Caster Angle	8^0
Camber Angle	0^0
King pin Inclination	10^0
Scrub Radius	77 m
Minimum Turning Radius	1779.08 mm
Maximum Turning Radius	2440.97 mm

TABLE 14 WHEEL ALIGNMENT

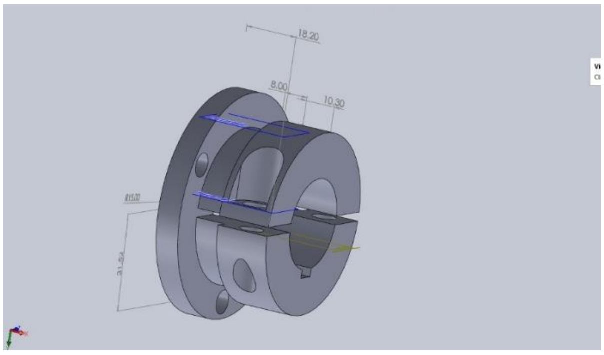

FIGURE 15 WHEEL HUB

➢ ENGINE AND POWER TRANSMISSION

Power Train

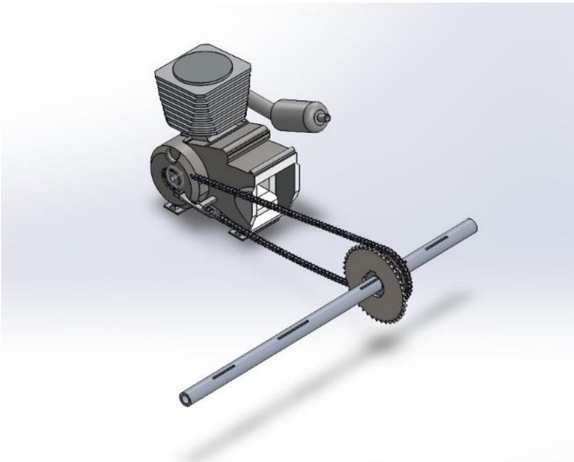

FIGURE 16 TRANSMISSION SYSTEM ASSEMBLY

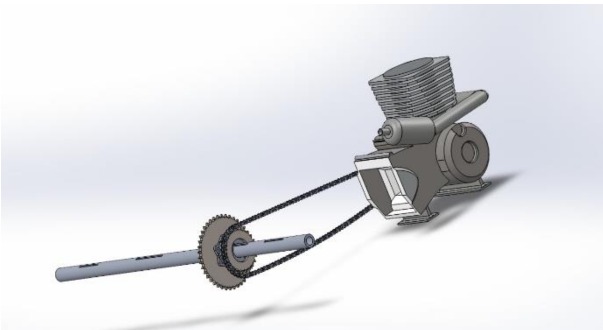

FIGURE 17 TRANSMISSION SYSTEM ASSEMBLY

Transmission components

Component	Material	Dimensions
Drive Shaft	Mild steel	1070 mm (length)
Bearing: UCF206	Stainless steel	30 mm
Key	EN8	8 mm × 5 mm ×
Fuel Tank	ABS	120 mm × 17 mm × 210 mm

TABLE 15 TRANSMISSION COMPONENTS

Engine Selection

There had number of options for the selection of engine such as Honda shine, Bajaj discover, TVS Phoenix etc. After long research work and survey, it is decided to use Hero Hunk 150cc engine to power a kart. It has inbuilt gear box of manual 5 speed constant mesh gear box, with the multi plate wet clutch. So, the design is according to the engine specification

Hero hunk engine is used in making the kart. Its specifications are given below

Parameters	Specifications
Engine name	Hero Hunk 150
Displacement	149.2 cc
No. Of cylinders	1
Max power	11.64 KW @8500 rpm
Max torque	13.5 Nm @7000 rpm
Gear box	5 speeds
Bore	57.3 mm

TABLE 16 ENGINE SPECIFICATION

Engine Positioning

We have opted for a side mounted engine rather than rear mounted engine in our go-kart.

The following are the advantages:

- We have made a compact kart reducing the wheelbase and the total length thus reducing the turn radius of the vehicle.

- We have obtained better traction and grip for our vehicle.

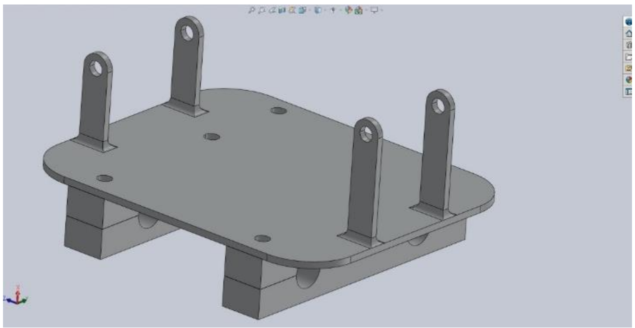

FIGURE 18 ENGINE MOUNT

Sprocket Selection

We decided to use 2 sprockets depending on the requirement of speed and acceleration and torque required for the track.

Maximum Acceleration		$14.42ms^2$
Material		Mild steel
Number of Teeth	Sprocket 1	43
	Sprocket 2	26
Chain pitch	13 mm	

TABLE 17 SPROCKET DETAILS

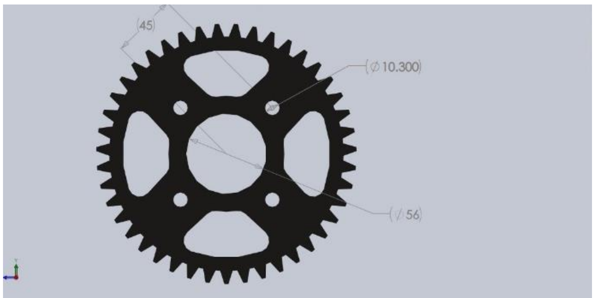

FIGURE 19 SPROCKET 1

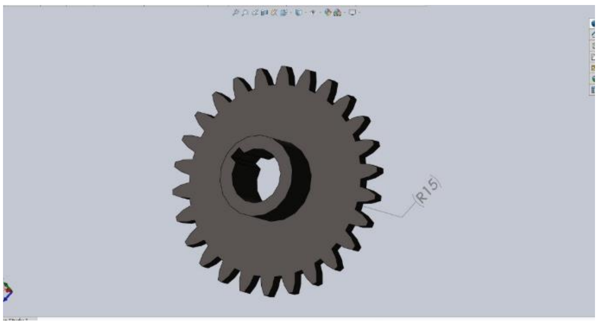

FIGURE 20 SPROCKET 2

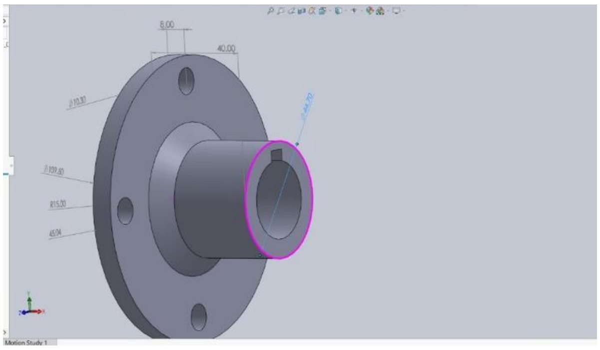

FIGURE 21 SPROCKET HUB

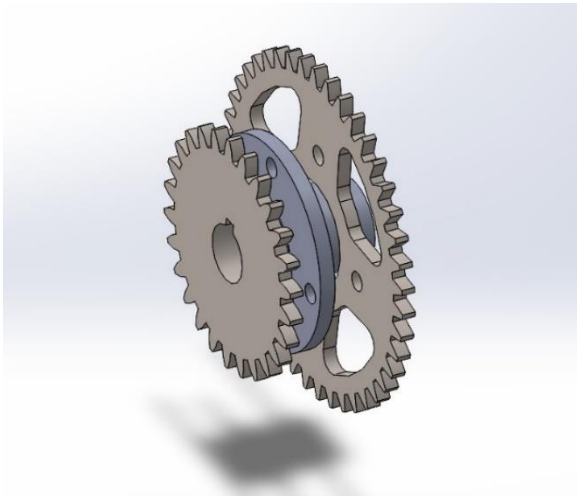

FIGURE 22 SPROCKET HUB ASSEMBLY

Gear Shifter

We have used manual transmission using a push-pull rod. We maintained a simple design to minimize losses and make troubleshooting easy.

The gear shifter was placed towards the left with respect to the driver and the height of the knob was adjusted in such a way that it was in level with the steering wheel, within the reach of the driver. This was done in order to minimize shift timings while driving.

➢ BRAKING SYSTEM

The main objective of the brakes is to stop the car safely and effectively. The braking system was designed by determining parameters necessary to produce a given deceleration and comparing to the deceleration that a known braking system would produce.

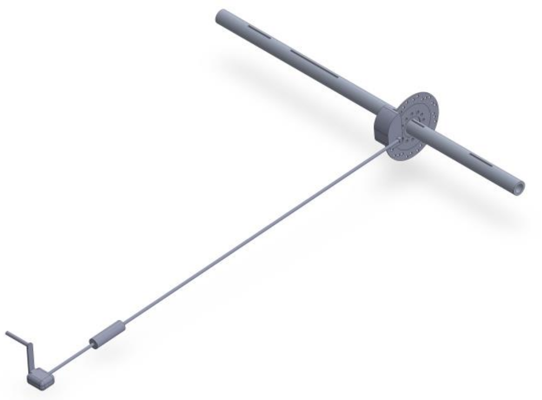

FIGURE 23 BRAKING ASSEMBLY

DESIGN OBJECTIVES

The objective of Braking System is

- to provide reliable and prompt deceleration of vehicle.
- In order to achieve maximum performance from the braking system, the brakes have been designed to lock up rear wheel, while minimizing the cost and weight.
- Moreover, the driver must have complete control of the vehicle while brakes are actuated.

Brake disc

Disc brakes will be incorporated at the rear axle shaft of the go-kart.

The advantages and the reason of selection of disc brakes over conventional drum brakes were simple.

Disc brake assembly proves to be lighter in weight. They're more reliable. They provide consistent and stable output, also in every weather conditions. The performance is better and quick at higher speeds. The disc brakes result in lesser wear.

Their advantage as thermally observed is higher heat dissipation at all temperatures due to proper and sufficient contact of the disc and air. Working force required is also at its minimum.

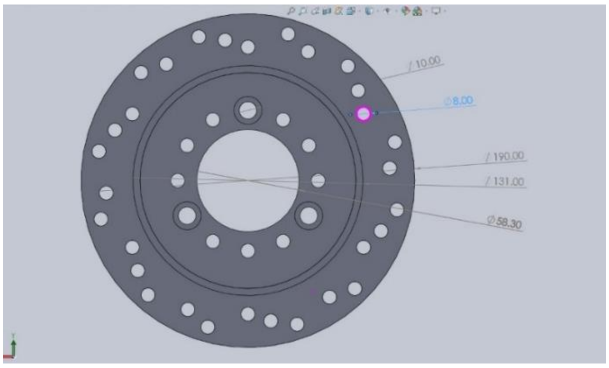

FIGURE 24 BRAKE DISC

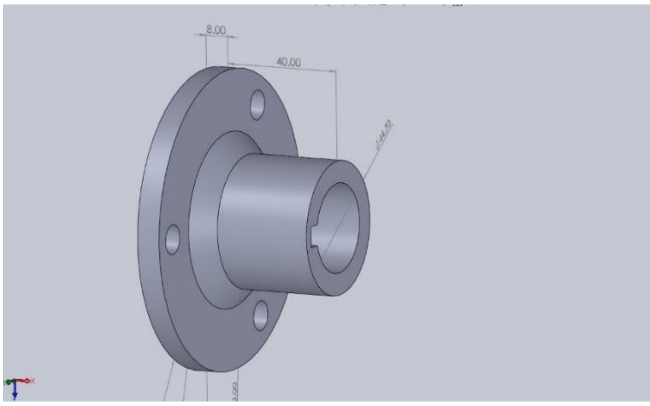

FIGURE 25 BRAKE DISC HUB

Pedals

Considering overall ergonomic parameters and driver comfort ability, the brake pedal is mounted at the foot of the driver, thus resulting into complex fabrication, and favouring design simplicity. The pedal ratio of 5:1 is taken in account for the brake pedal.

Pedal Ratio	5:1
Thickness	6 mm
Material	AISI4130

TABLE 17 PEDAL SPECIFICATION

We made holes and slots where stress was less for reduction of weight.

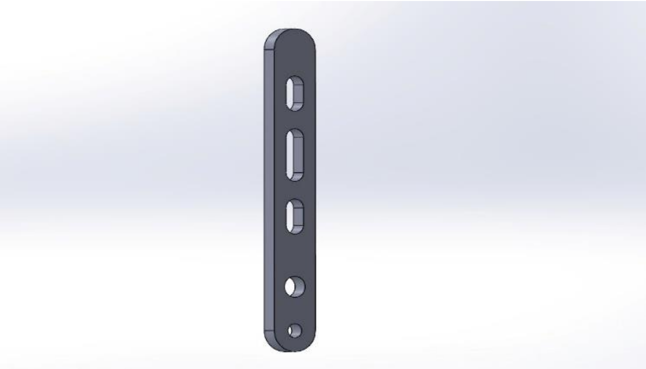

FIGURE 26 BRAKE PEDAL

BRAKE FLUIDS

We have decided to use DOT 3 Brake fluid

- Economical
- Easily available
- Compatible

For safety purpose appropriate hydraulic circuits and lines are provided.

➢ SAFETY EQUIPMENT

Safety was the main priority while designing the entire go-kart. Bumpers are provided for safety. In addition, fire extinguishers and kill switches will also be used in case of emergency. Ergonomics are designed perfectly for the comfort of the driver.

Kill switch is provided in our vehicle in order to provide safety to the driver. In case of any emergency the driver can push the kill switch so that the engine would stop functioning. The electronics are designed so that when the kill switch is depressed, power is disabled on primary ignition coil of the engine.

In the case of emergency, if the vehicle breakdown in the middle of the race, the system can be activated and the driver themselves can move the vehicle to a safe place. No human effort is needed.

Insulated wires of high safety were used to avoid any risks

➢ ELECTRICALS

12V DC Battery will be used to power all the electrical components.

➢ FABRICATED AND PREFABRICATED PARTS

As the focus of this project was learning and developing skills, we emphasized on trying to fabricate maximum components by ourselves.

Fabricated	Prefabricated
C-clamp	Engine
Chassis	Brake calliper
Engine mounts	Master cylinder
Bumper mounts	Tyres
Caliper mounts	Fuel tank
Steering system	Fairings
Shaft	Seat
Wheel and sprocket hubs	Bumpers
Bearing mounts	Steering wheel
Sprocket	

TABLE 18 FABRICATED AND PRE-FABRICATED PARTS

➢ Innovation

Use of 2-sprockets of different gear ratio will give the required speed and torque properties that the track would demand as per the required racing conditions for better and effective performance.

This is achieved by moving the sprocket sub-assembly on the shaft through the extra keyways given and locking the desired sprocket using circlips on either side of the sub-assembly.

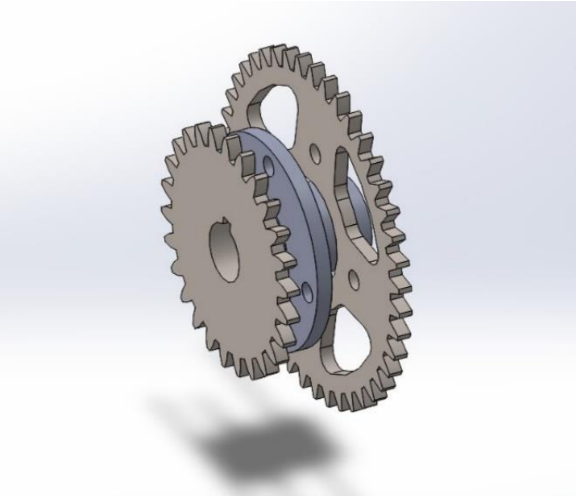

FIGURE 27 DOUBLE SPROCKET

➢ Conclusion

The basic need of Go-kart vehicle is less weight to strength ratio. Keeping fabrication in the mind, we tried to make the design optimum and simple with high in strength and stability. The design of the chassis for Go-Kart helps to finding the strength and weakness of the design and fabrication.

The design and construction of GO-KART has become more challenging due to the increased participation. Our team is participating for the first time in this event so a detailed study of various automotive systems is taken as our approach. Thus, this report provides a clear insight in design of our vehicle.

The team has started well in advance in order to give more stress on practical testing, the team is confident with the work that has been completed so far and is sure that they will successfully complete & compete in the competition. Although the road to the neuron position is very long and bumpy, the team feels confident that it will continue to make its mark.

➢ Reference

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[2] Rulebook, IKC – 5

[3] DETAILED ESIGN CALCULATIONS & ANALYSIS OF GO-KART VEHICLE-vinash Barve[1], Vivek Gurve[2], Gaurao Tapre[3], Arvind Totey[4] Scholar Mechanical Engineering, S. B. Jain Institute of Technology Management and Research, Nagpur, India[1, 2, 3] Assistant Professor, Mechanical Engineering, S. B. Jain Institute of Technology Management and Research, Nagpur, India[4]

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[5] Design and Fabrication of Race Spec Go-Kart Simranjeet Singh, Aniket Badgujar, Pushparaj Patil, Gaurang Kadam 1,2(Automobile, Rajendra Mane College of Engineering and Technology, India)

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