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DESIGN, ANALYSIS AND FABRICATION OF GO-KART

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Abstract— A Go-kart is a small four wheeled vehicle. Go-kart, by definition, has no suspension and no differential. They are usually raced on scaled down tracks, but are sometimes driven as entertainment or as a hobby by non-professionals. 'Carting is commonly perceived as the stepping stone to the higher and more expensive ranks of motor sports. Kart racing is generally accepted as the most economic form of motor sport available. As a free-time activity, it can be performed by almost anybody and permitting licensed racing for anyone from the age of 8 onwards. Kart racing is usually used as a low-cost and relatively safe way to introduce drivers to motor racing. Many people associate it with young drivels, but adults are also very active in karting. Karting is considered as the first step in any serious racer's career. It can prepare the driver for highs-speed wheel-to-wheel racing by helping develop guide reflexes, Precision car control and decision-making skills. In addition, it brings an awareness of the various parameters that can be altered to try to improve the competitiveness of the kart that also exist in other forms of motor racing.

Index Terms— Go-kart, Racing, Design, Frame, Analysis, Steering System, Braking System, Engine, Transmission, Innovtion.

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1 INTRODUCTION

Go-kart is a simple four-wheeled, small engine, single sealed racing car used mainly in United States. They were initially created in the 1950s.Post-war period by airmen as a way to pass spare time. Art Ingels is generally accepted to be the father of karting. He built the first kart in Southern California in 1956. From them, it is being popular all over America and also Europe.

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2 FRAME DESIGN

2.1 Frame Material

The material used for the frame is AISI 1080 MILD /LOW CARBON STEEL as it has reasonable price and provide enough safety to the driver. The pipe is of 1 inch diameter having 3mm thickness. The physical properties of the pipe are as follows.

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The chemical composition of the pipe is as follows.

SL.No	PROPERTIES	VALUES
1.	Tensile strength	440 MPa
2.	Yield strength	370 MPa
3.	Bulk Modulus	140 GPa
4.	Shear modulus	80 GPa
5.	Young's Modulus	205 GPa
6.	Poisson's ratio	0.290

The chemical composition of the pipe is as follows.

MATERIALS	PERCENTAGE
Carbon	0.14-.0.20%
Manganese	0.60-0.90
Phosphorous	≤ 0.040 %
Sulphur	≤ 0.050 %
Iron	98.8 - 99.26 %

2.2 Proposed Design Of The Vehicle

The 3-D views of the completed vehicle are shown below.

Fig. Isometric view of the vehicle

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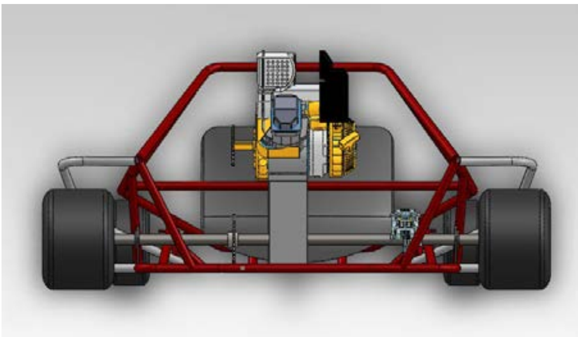

Fig. Rear view of the vehicle

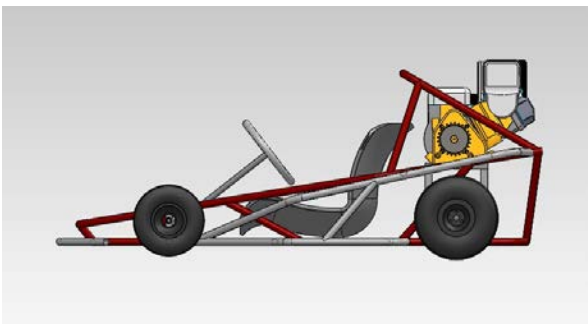

Fig. Side view of the vehicle

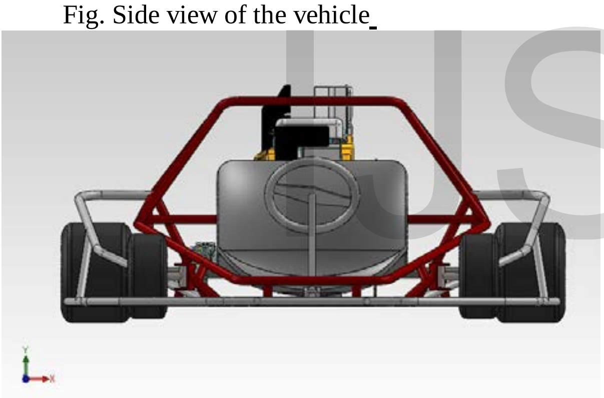

Fig. Front view of the vehicle

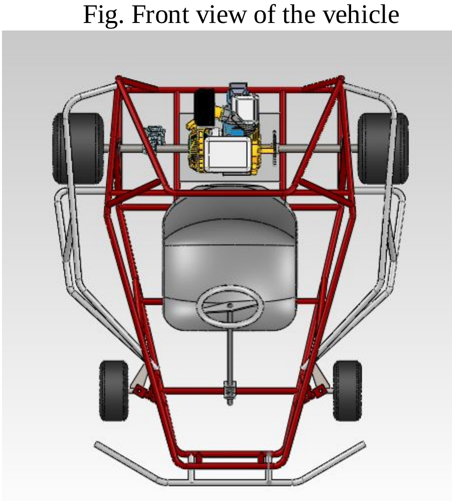

Fig. Top view of the vehicle

2.3 Frame FEA Safety Analysis

Aside from exceeding the minimum material requirement set by the discussion in team members. Standard values of the material are compared with the analysed result to verify the structural integrity of the frame. At critical points of the wireframe model of the frame, theoretically calculated loads are placed in order to stimulate the maximum force the vehicle can bear from its own weight and the driver in the event of collision. Frame analysis was conducted in INVENTER software. While meshing, the number elements was found to be 35955 with 70392 nods. For the conduction of finite analysis of the frame an existing design of the frame is uploaded from the computer. Three different induced load cases are considered for the calculation of stresses. Three cases were frontal impact, side impact and rear impact. Impact test on the frame is conducted according to ENCAP (European New Car Assessment Programme). According to ENCAP, linear Velocity remains at 64 Kmph for frontal impact, 48 Kmph for side impact and 50 Kmph for rear impact.
The frame analysis calculations are done as follows.

2.3.1 Front Impact Analysis

The front impact test is carried out as
Mass of the vehicle (estimated) M = 180 Kg
Velocity V = 64 Km/h = 17.8 m/s
From mass moment of inertia equation,
Frontal impact Force F = P x ΔT
Where,

P = momentum

ΔT = duration of time = 1.1 seconds

P = M x V
= 180 x 17.8
= 3204 Kgm/s

F = P x ΔT
= 3204 x 1.1
= 3524.4 N

Now keeping the rear part fixed the calculated force applied to the front part of the frame in INVENTER. The image sbelow shows the results of deformation, Von-mises stress and safety factor respectively.

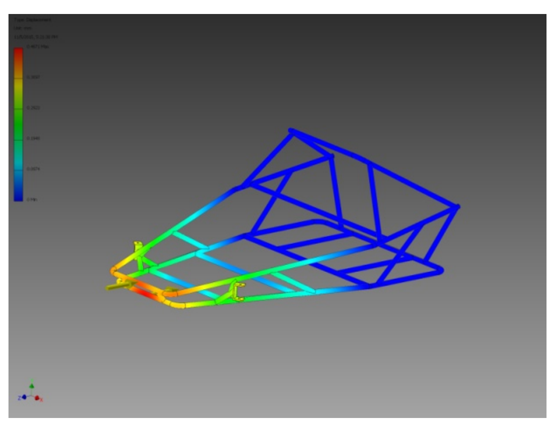

Fig. Deformation

The maximum deformation is found to be 0.48 mm which is very small and it is safer to use.

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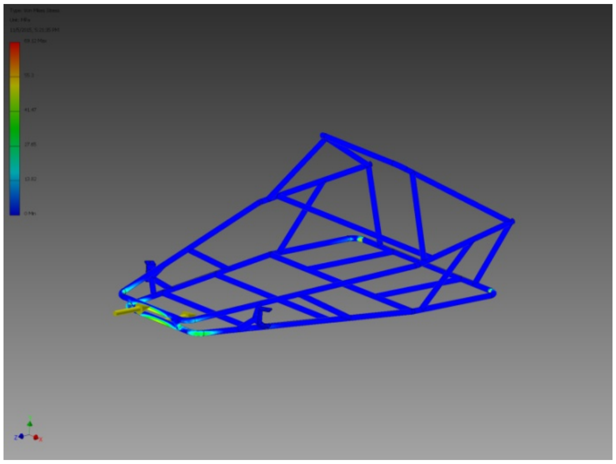

Fig. Von-Mises Stress

Maximum stress is found to be 69.12 MPa. It is a safe value.

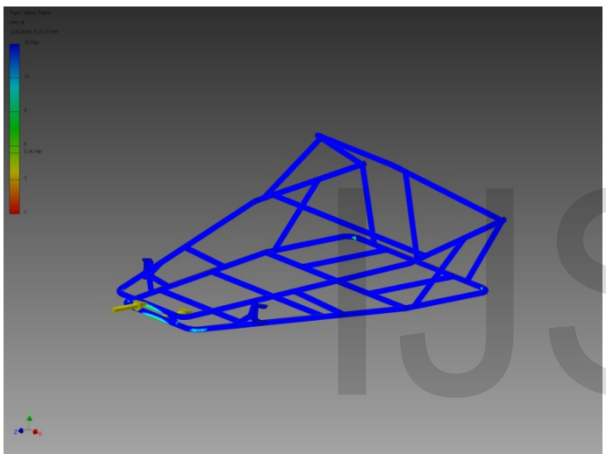

Fig. Safety Factor

From the analysis, safety factor is found to be 15 at the maximum, not less than 5. So it is acceptable.

2.3.2 Side Impact Analysis

Side impact Force F = P x ΔT

where P = M x V

M = 180 Kg

V = 48 kmph = 13.3 m/s

P = M x V

= 180 x 13.3

= 2394 Kgm/s

F = P x ΔT

= 2261 x 1.1

= 2633.4 N

Now keeping one side of the frame fixed the calculated force is applied on the other side of the frame in INVENTER.

The image below shows the result.

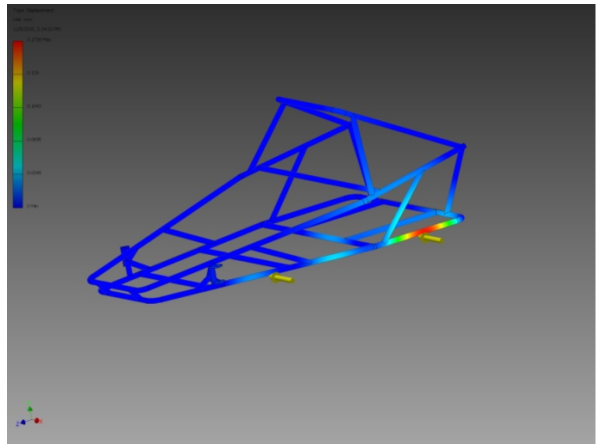

Fig. Deformation

The maximum deformation is found to be 0.173 mm which is very small and it is safer to use.

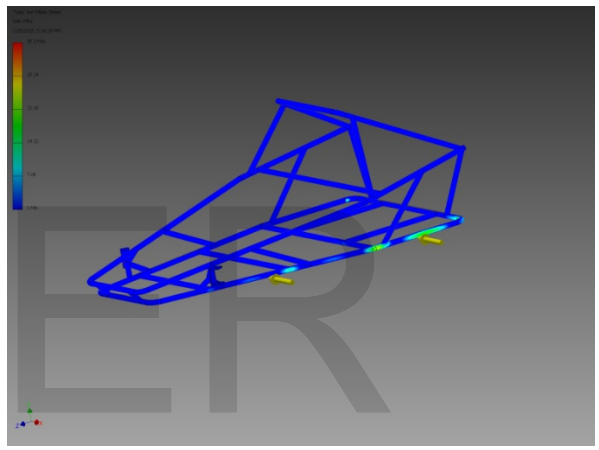

Fig. Von-Mises Stress

Maximum stress is found to be 35.3MPa. It is a safe value.

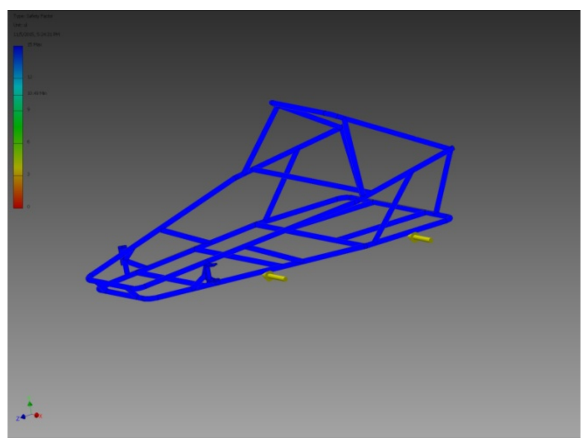

Fig. Safety Factor

From the analysis, safety factor is found to be15 not less than 5. So it is acceptable.

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2.3.3 Rear Impact Analysis

Rear impact Force F = P x ΔT
where P = M x V
M = 180 Kg
V = 50 kmph = 13.8 m/s
P = M x V
= 170 x 13.8
= 2484 Kgm/s
F = P x ΔT
= 2346 x 1.1
= 2732.4 N

Now keeping the front part fixed the calculated force applied to the rear part of the frame in INVENTER. The image below shows the result.

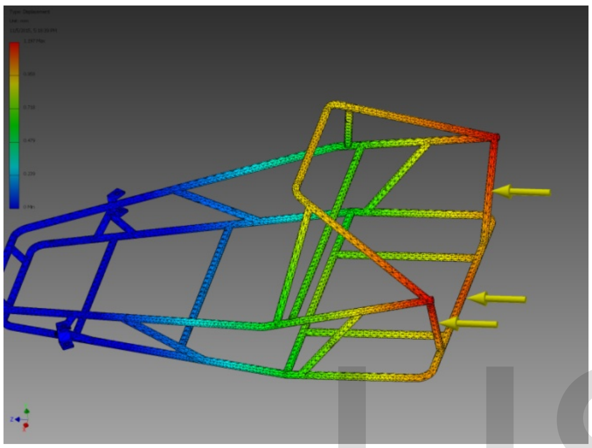


Fig. Deformation

The maximum deformation is found to be 1.197 mm which is very small and it is safer to use.

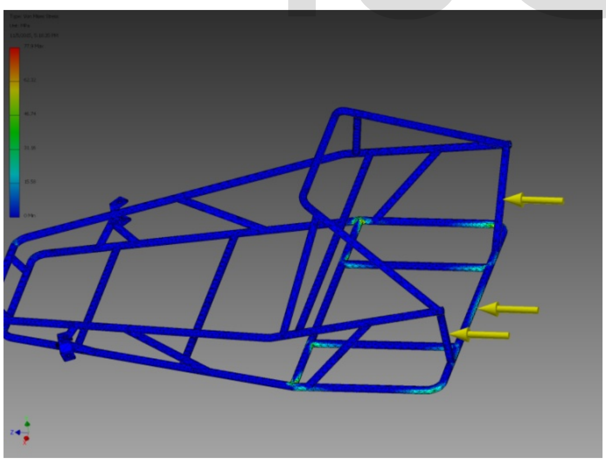


Fig. Von-Mises Stress

Maximum stress is found to be 77.9MPa. It is a safe value.

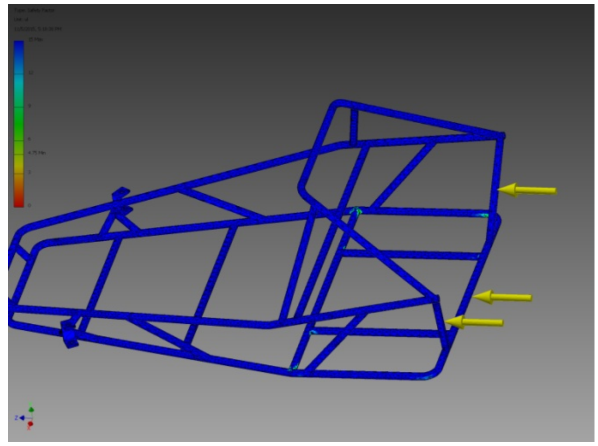


Fig. Safety Factor

From the analysis, safety factor is found to be 15, not less than 5. So it is acceptable.

2.4 Conclusion

Conclusion for the safety analysis is tabulated below.

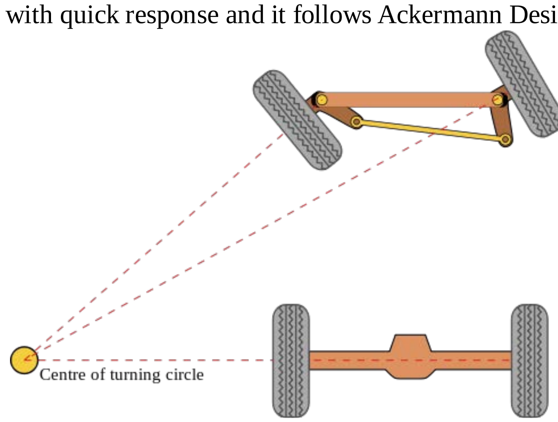
FACTORS	FRONT	REAR	SIDE
Impact Force	3524.4N	2732.4 N	2633.4 N
Stress Generated	14045.49N/m^2	1088.8 N/m^2	1049.42N/m^2
Total Deformation	0.48 mm	1.197mm	0.173 mm
Safety factor (min)	5.35ul	4.75ul	10.47ul

Factor of safety F.O.S. = Design Stress/Yield Stress

3 Steering System

The steering system is the key interface between the driver and the vehicle. The main objective of the steering system is to provide directional control to the vehicle with . It must be smooth, compact and light. it must also be precise and must also provide the driver a perfect control of the vehicle.

Our steering system is designed to provide easy manoeuvring with quick response and it follows Ackermann Design.



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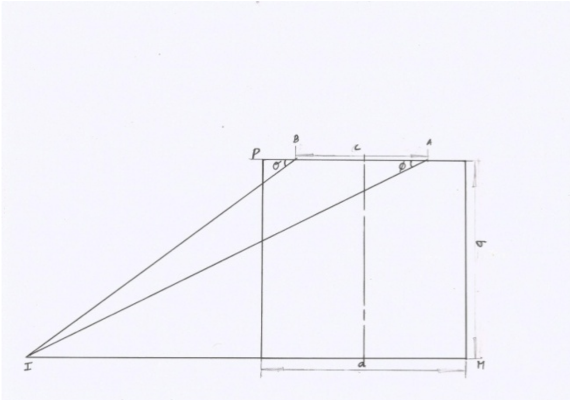
3.1 Calculation

Track Width (a) = 990 mm
Wheel Base (b) = 1030 mm
Pivot to pivot point (c) = 710 mm
Let outer turning radius R_o = 2600 mm



Where,
α = Ackermann angle

$$TW - (2 \times Ackermann\ arm) = \sin\beta$$
$$Ackermann\ arm = 494.8363\ mm$$

The value of turning radius is assumed to be 2.6m. Also the values of TW and WB are 990mm and 1030mm. Substituting these values, the value of Ackermann arm is found to be 519.8143mm. Now, the values of inner and outer angles are:

$$inner\ angle\ \alpha_1 = 39.047°$$

Consider Δ ABP,
cotθ = BP/IP
= 1434/1024
$\boldsymbol{\theta}$ = 35.42^0
Consider Δ IAP,
cotØ – cot$\boldsymbol{\theta}$ = c/b
cotØ = 2.086y
Ø = 25.61^0
Inner turning radius R_i = (b/sin$\boldsymbol{\theta}$)/((a-c)/2)
= (1020/sin35.2)/((1058-694)/2)
=
Ackermann angle = tanα =(c/2)/b
= (694/2)/1020
α = 18.7^0

The turning radius and turning angles are calculated graphically and arithmetically. Graphical values and arithmetical values are approximately equal.

4 Braking System

A disc brake is a wheel brake that helps to slow down the speed of the vehicle by the friction caused by pushing brake against the disc with a set of callipers. Discs are mostly made from cast iron. They are fixed on the axle. When brake calliper is forced mechanically, pneumatically or hydraulically against the both sides of the disc, friction occurs and thus the vehicle can be stopped.

The main objective of the brakes is to stop the car safely and effectively.

No. of disc brake	1
Disc outer diameter	190mm
Disc inner diameter	30mm
Thickness	3mm
+Brake pedal force	150N
Pedal ratio	3:1
Coefficient of friction pad	0.6
Stopping distance	4.89m
Stopping time	0.88s
Total brake force	2295.225 N

At the time of braking, kinetic energy is converted into heat energy due to t he friction between calliper pad and rotor disc.
Kinetic Energy = $\frac{1}{2}mv^2$
= 180 x 11.11^2 /2
= 11108.889
Deceleration of the vehicle should not exceed 1.3G. μ = 0.6
Stopping distance of the vehicle is calculated by Newton Law's of motion.
$v^2 = u^2 + 2aS$
where,
v is the final velocity of the vehicle
u is the initial velocity of the vehicle
S is the stopping distance
S = v^2-u^2/ 2a
= 11.11^2/2x1.3x9.8
= 4.84 m
Breaking force = K.E/S
= 10491.73/4.84
= 2295.225 N

5 Power train

Briggs & STRATTON engine is used in making the kart. It's specifications are given below.

S. No.	Description	Type
1.	Displacement	208.5 cc
2.	Stroke	4 Stroke
3.	Cooling	Air Cooled
4.	Dry weight	18 kg
5.	Max. Power	6.5bhp
6.	Gross. Torque	**@3060 rpm :**12.9 Nm

6 Wheels

Wheels allow the vehicle to move smoothly on a surface. We're using go kart tyres having the dimensions 10X4.7X5 inches for the front wheel and 11X7.1X5 inches for the rear whee

7 Innovation

SELF RECOVERY SYSTEM

Two wiper motors of high torque or moulded with the centre of the frame with two rubber wheels connected to

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it.The wiper motors are then connected to the car battery in order to get the electrical input of the motor.

7.1 Component

- Wiper motor
- Connecting wires
- Switch
- Caster wheels
- Electric jack

7.2 Working

- Wiper motors are moulded with a hinge joint at the centre of the frame so as to provide the easy up and down movement of the wheels when necessary.
- When the car is having any engine trouble and not working properly or the driver need to take reverse his kart, the self recovery system can be activated.
- By pressing the up and down switch the electric jack connected to the rod connecting the two wipers hinge joint moves up and down and thereby lifting the rear wheels of the kart and making the wheels connected to wiper then acts as the rear wheels of the car.
- Thus by the torque created by the wiper help to move the kart according to drivers wish which can be controlled by the steering.

7.3 Advantages

- 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.
- Kart can be driven in reverse
- No human effort is needed

8 Kill switch 9 Body Works And Seat

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.

9 Body Works And Seat

Body works are fabricated in moulding workshops as per the design. Go kart seat which is adjustable gives extra safety and comfort to the driver as per their heights and position to the driver when compared to the normal seats. Body works give an exterior appearance and provide some safety.

10 Conclusion

To achieve the set goals, Team Raptorz used the finite element for the evaluation, creation and modification of the best vehicle design. The prior aim of the team was to build a go kart with minimum cost without compromising the safety and performance of the vehicle. The final result is a desired Go Kart design meeting all the above factors.

11 Acknowledgment

Frst of all we thank God the Almighty for all his blessings and then our parents for their support from the beginning. We take this opportunity to thank our college, "UKF College Of Engineering and Technology, Kollam" for allowing us to use the Workshop and CAD facilities in the campus. We are very much indebted to our General Secretary and our beloved principal. We express our sincere gratitude to them. We offer our heartfelt gratitude to The head of the Department, Mechanical Engineering for his motivation and blessing. We also thank all our faculties and students who wished for the success of the kart.

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