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Design and Development of Braking and Transmission Systems in Go-kart

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Abstract: Go kart is a four wheeled vehicle, mostly used globally as a motor sport. The idea of Go-kart is to make a vehicle out of scraps/ used parts of other vehicles. The following paper deals with design and installation of braking system in the Go-kart. The following paper deals with design with the design and installation of braking and transmission system in Go-kart. The braking system used here is a hydraulic disc brake with double piston caliper.
Keywords: Go kart, Braking, Engine, Resistance, Efficiency

I. INTRODUCTION

A brake could also be a tool by means of which artificial frictional resistance is applied to a moving membrane so on retard or stop the motion of the vehicle. In the process of braking the brake absorbs the K.E. of the vehicle and transforms within the sort of heat. Then the warmth energy is transformed to the atmosphere by convective heat transfer. The main requirement of the braking system is to prevent the vehicle at minimum distance after applying the brake, theoretical calculations are done and therefore the stopping distance, temperature rise in disc and stopping time are calculated. The theoretical results go hand in hand with the sensible results.
In order to pick the simplest braking system for Go-kart, basic research work is completed on sorts of braking system and hydraulic brakes is chosen , since it's very effective compared to drum brakes and it reduces the planning complexity and helps to scale back the general weight of the kart.

A. About Go–kart

Kart racing is typically used as a low-cost and comparatively safe thanks to introduce drivers to motor racing. Many people associate it with young drivers, but adults also are very active in karting. Karting is taken into account because the initiative in any serious racer’s career. It can prepare the driving force 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 varied parameters which will be altered to undertake to enhance the competitiveness of the kart that also exist in other forms of motor racing.

B. Scope of the Project

Go-Karting may be a big craze to the Americans and Europeans. It is initially created in us in 1950s and used as how to pass spare time. Gradually it became an enormous hobby and other countries followed it. In India go-karting is preparing to form waves. A racing track is prepared in Nagpur for go-karting and Chennai is additionally trying to form one.
Indian companies also are producing go-karts in small scale. MRF and Indus motors are the main bodies in karts and that they are offering karts between 1lakh and three lakh. But to form go-karts popular, the worth must come down. For that, many of us try to create one under 1 lakh and that we had also take up the challenge. A go-kart just under Rs. 25,000/-. So we are sure that our project will have a high demand within the industry and also we hope to urge orders from the racing guns.

C. Departments in Go–kart

In a Go-Kart, there are mainly five departments. They are,
1) Chassis
2) Steering system
3) Transmission system
4) Braking system
5) Electric System

D. Parts and Specifications

Table No .1.Parts And Specifications Of Braking

Terms	Used
Front axle static load	74 kg
Rear axle static load	111 kg
Gross weight (Kart + driver)	185 kg
Stopping distance	12 m
Weight transfer	26 kg
Leverage	5:1
Load applied by the driver	100 N
Braking force	1269.1 N
Braking torque	105 Nm
Stopping Time	S

E. Components we are Using

Table No. 2. Components of braking

COMPONENTS	SPECIFICATION
Brake Disc	150 mm (dia.) of Yamahafascino125
Master cylinder	$2.01*10^{-4}$ m^2 (area) of TVS apache
Brake fluid	Dot-3
Caliper	26 mm (dia.) of Bajaj pulsar

II. THEORY

A. Disc Brakes

A Disc brake is a braking system used in wheels which slows down the rotation of wheel by friction generated on the rotor disc by push brake pads with the help of caliper sets. These brakes are usually made of cast iron, but in recent cases they are made of composite materials such as reinforced carbon-carbon and other ceramic matrix composites.

Disc brake system was found in America around 1970s. Earlier they were used in few cars and a decade after it was used in almost all modern card and light weight trucks in front as well as in all four wheels. (Gilles, 2004)

B. Parts of Braking system

1) Brake pedal – Controlled by driver
2) Brake booster – Enhances braking effectively
3) Master Cylinder – Pascal's law to multiply the force by means of hydraulics
4) Caliper and Disc – Contacting parts to serve the purpose of driver(Either stopping or slowing down)
5) Brake lines – Connection to transfer the hydraulic power to the brake caliper
6) Brake fluid – Hydraulic agent to transfer power from Master piston to brake piston
7) Connecting rod – Metallic part to deliver drivers response from brake pedal to piston of master cylinder.

C. Operation and Mechanism

Disc brake consists of a rotor (disc) and a set of caliper which is similar to bicycle brake as shown in Figure 2-2

Fig.1 Actual representation of braking system

O-ring made from rubber with square cut seals the disk brake that applies piston to its bore. While comparing with drum brakes system, the disk brake system doesn't require spring element to return the brake to its original position after brake release, Instead the O-ring distorts while braking and when released, the seal returns it to its original position by pulling the piston back and allowing the linings to release the rotor. The linings, pad, glides which is found on the surface of the rotor disc are designed in such how to wipe off contaminants. (Gilles, 2004)

1) *Brake Pedal to Brake Caliper:* As soon as the driver applies foot effort on the brake pedal, the force generated transfer to the piston present in the master cylinder as shown in the Figure 2-3. Then the piston from the brake cylinder applies pressure to the brake fluid present within the cylinder by passing through the brake lines. And then it transfers to each and every brake calipers to prevent the wheels.
2) *Brake Caliper to Wheels:* When the brake caliper mechanism receives the hydraulic fluid in the cylinder, it forces the piston in brake caliper to push the brake pad towards the rotor disc. By this manner the motion of the wheels are going to be arrested by the restraint. Here the kinetic energy of the wheels is transferred in the form of heat energy to the brake power depending on the torque generated by the wheels. Higher the torque, higher the warmth energy generated to the pads also on atmosphere. In order to face up to heat and stresses induced while braking, the fabric for the brake pad, brake lines and rotor disc should be chosen carefully.

D. Advantages of Disc brakes

1) When the linings on the rotor disc get wear, the piston slides forward to the bore to self- adjust with the slack though it consumes more fluid from the reservoir.
2) They even have a mechanism of hand brake which will automatically adjust the piston to string forward to manage the clearance.
3) They're relatively light in weight, less expensive and better cooling.
4) Less distortion when subjected to lining force in comparison with drum brakes systems
5) Braking efficiency is more compared to drum brakes, since the contaminants falls of the rotor avoiding wear in restraint
6) Disc brakes are good to be used as front brakes, thanks to the effect it applies on all sides of auto avoiding shlep one particular direction, where as it is impossible in drum braking which ends up in unequal lining wear thanks to uneven size of the drum diameters. (Gilles, 2004)

E. Braking System Design/Testing Checkpoints

The design and testing of the braking system should have the subsequent check points before designing.

1) Braking Effectiveness
2) Braking efficiency
3) Stopping Distance, lightly and fully laden
4) Response time
5) Partial Brake system failure
6) Brake fluid volume analysis
7) Thermal Analysis
8) Emergency and Park brake
9) Specific Design Measures
10) In-Use factors
11) Component sizing
12) Safety regulations

F. Design Solution Selection process

For designing a braking system, the subsequent rules should be followed while completing each and each step

1) Considering all the constraints, the simplest yielding reasonable design should be compromised.
2) The basic requirements and wishes should be determined clearly and precisely.
3) Instead of running production changes after implementation, one best simple design are going to be fine enough
4) It isn't required that the primary design will always be the simplest one.
5) Design Optimization should be followed during a systematic approach.
6) Each and each design concepts should be clearly evaluated with alternate solutions.
7) Variation in concepts should be practiced.
8) To get obviate the assembly cost, the fabric cost should be minimized while designing.
9) To be used globally, every design considerations should be standardized
10) Valid Complaints brings out a legitimate design considerations and inputs.
11) Accident database should be investigated which are relevant to brake failures.
12) A ranking matrix would help in obtaining the simplest design on considering cost, safety also as other influential factors.

III.DESIGN

A. Design Methodology

A brake is a device which is used to retard or stop the motion of machine by means of artificial frictional resistance is applied to a moving machine member. Brakes are generally applied to rotating axles or wheels but can also take other forms like surface of a moving fluid (flaps developed into water or air).Some vehicles used combination of braking mechanism, like drag racing car's with both wheel brakes and a parachute, or airplanes with both wheel brakes and drag flaps rise into the air during landing. Most brakes commonly use friction between two surfaces press together to convert the K.E. of the moving object into heat, through other methods of energy conversion could also be employed.

B. Design calculations[7]

Parameters: Mass of vehicle = 150 kg

Maximum speed of vehicle (s) = 80kmph (22.22m/s)

Tire radius (r_{tire}):= 139.70mm

Height of C.G from ground surface (h) = 200mm

1) Calculation Of Stopping Distance And Time

u=initial velocity in m/s;

v=final velocity in m/s;

a=deceleration rate in m/s2;

s=stopping distance; t=braking time;

v=0; u=80 kmph (22.22m/s)

Assuming deceleration a=1 x g=9.81m/s2

(i.e. a=µxg; µ=the coefficient of friction between road and tire Assuming µ=1 for asphalt and slick tires)

Using Newton's 3rd Kinematic equation,

v2=u2+2as s=25.17m Using Newton's 1st Kinematic equation

v = u + at t=2.56sec The stopping distances and braking time while stopping the kart to rest from various speeds are listed in following table: 2 Dynamic weight transfer:

Dynamic weight transfer is the amount of change of vertical loads of the tires due to longitudinal acceleration imposed on Centre of Gravity of the car. Total static mass of vehicle including driver =150 kg (Static weight distribution is assumed to be 40%front and 60% rear) Height of C.G from the ground surface (h) =200mm Wheelbase (b) =1070mm

(Fs)F =Static weight on front wheels = 150 x 9.81 x 0.4 = 588.6N

(Fs)R =Static weight on rear wheels = 150 x 9.81 x 0.6 = 882.9N

F_d = Force due to dynamic weight transfer

$$F_d = \frac{m\,a\,h}{b}$$

$$= \frac{150 \,X\, 9.81 \,X\, 200}{1070}$$

$$= 275.05 \text{ N}$$

Total dynamic weight on Front axle $(F_d)_F=(F_s)_F+F_D$ = 588.6 + 275.05 = 863.65N

Total dynamic weight on Rear axle $(F_d)_R=(F_s)_R-F_D$=882.9 - 275.05=607.85N

2) Master Cylinder & Caliper Selection

As only one disc is used on rear rigid driving axle weight on only rear wheels is considered. Maximum driving torque without slipping condition is:

$T_f = (F_d)_R \times \mu \times r_{tire}$ = 607.85 x 1 x 0.1397

=84.9N-m

Single piston caliper is suitable for required braking torque. Available single piston caliper in market is rear Brake Caliper of Bajaj Pulsar 220. The diameter of that Caliper is 32mm.

As there is only one disc used for braking the rigid driving axle, Master Cylinder (MC) is preferred over Tandem Master Cylinder (TMC) to avoid blocking extra outlet port.

3) Design of Braking Circuit

We found the force applied by foot of driver by using spring balance to be 150N on an average. We have assumed a pedal ratio of 6 :1 to achieve an optimum pedal travel and minimum driver effort.

Table no .3. Braking circuit

Pedal force applied by driver (F_a)	= 150N
Brake Pedal Ratio	= 6 : 1
Force applied to master Cylinder (F_1)	= 900N
Diameter of Master cylinder piston (D_1)	= 12mm
Area of master cylinder (A_1)	= 11.31×10^{-5} m^2
Brake fluid Pressure (P) = F_1 / A_1	= 79.57bar
Diameter of caliper piston(D_2)	=32mm
Brake caliper piston area (A_2)	= 8.042×10^{-4} m^2

According to Pascal's Law, Assuming pressure is transmitted without any loss to the Caliper Force Transmitted to Brake caliper (F_c) = PxA_2 =6399.02N

Total force transmitted to brake pad(F_p)=2×F_c =12798.038N

Braking Torque (T_b) = $F_p \times \mu_{pad\&disc} \times r_{effective}$

=12798.038×0.33×(0.07)

Where $r_{effective}$ = radius at which pad apply force on disc

Tb = 295.63 N-m

Hence braking torque is greater than the required frictional torque So wheels will get locked. The brake pedal has an adjustment of 2 pedal ratios as 4.5:1 and 3:1.

Hence, according to driver feedback, pedal ratio can be adjusted, depending upon the track conditions and dynamic events.

4) Rotor Specifications

We are going to manufacture disc of our own design. Specifications of disc are:

Material = EN8

The reason behind selecting EN8 is to obtain high strength, specific heat, better heat transfer and good thermal conductivity of the disc.

Outer dia. = 150 mm

Effective radii = 75 mm

Thickness =4 mm

PCD= 80mm (3 bolts of dia 8)

Fig. 2. Brake rotor and Hub

5) Design of Rotor Hub

Material: EN8

For EN8 σ_{yt}=323.23 MPa

Torque to be transmitted (M_t)= Torque due to traction

= μ x m x g x 0.6 x radius of tire

= 123.3411 N-m

=123341.1 N-mm

Fixing the hub length as 30mm,

Shaft diameter = 25mm

Hub diameter (d_h) = 41mm

Thickness of flange (t) = 6mm

Force on hub=M_t / radius of hub

=123341.1/20.5

=6016.64N

Shear stress=F / A

=6016.64/ (π x d_h x t)

=6016.64/(3.14 x 41 x 6)

6) *Brake Pedal*

Pedal Calculation:

The force applied by foot of driver while braking is assumed to be 150N. The value is found out by taking a number of readings of force actually applied by our driver on spring balance and taking the average.

Force applied by foot of a driver on pedal (N) = Average reading in spring balance x 9.81 Now the pedal ratio is assumed to be 5.5 : 1

Force on master cylinder = Pedal ratio x Force on pedal by foot of driver

= 5.5 x 150

= 825 N

This force generates a pressure of 41.65 bar and a braking torque of 154.77Nm in the respective hydraulic circuit to lock the wheels. Required force on pedal for generating 123.34 Nm torque to lock the wheels is 120N. So, from above calculations application of braking force is in comfort of driver.

Selecting FOS = 2 D^3 = 4329.638

D = 16.253 mm

Calculation by Torsion for finite life S_{se} =0.577 x S_e

S_{se} = 99.643

$D^3 = 16 \times M_t / (\pi \times S_{se} / FOS)$

= 12606.804

D = 23.2007

Hence by using design for fluctuating load, the diameter obtained is 23.2007mm

IV. TRANSMISSION

A transmission is a device which consists of power source and power transmission system, which provides total control over the power generated by the source. Generally, transmission is considered as system in which different ratios are provided to achieve different torque and RPM outputs. In India Go-karts mainly uses two types of I.C. engines, geared and non-gear engines. Velocity of vehicle plays a vital role on dynamics of the vehicle, at low-speed acceleration is limited by the total mass inertia of the kart including driver; at high speeds air resistance is more effective than other resisting dynamic properties. The transmission system should be quite good enough to convert the available power from the source into driving force to overcome total resistance force and bring the kart in motion.[3]

A. *Systems Used in a Go-kart Transmission*

Like every automobile, go-karts also have various systems. Mainly there are 4 systems in this kart.

1) Fuel system
2) Ignition system
3) Lubrication system
4) Cooling system

The purpose of fuel system in SI engines is to store and supply fuel and then to pump to carburettors. The fuel supply system also prepares the air-fuel mixture for combustion in the cylinder and carries the exhaust gas to the rear of the vehicle. The basic fuel supply system used in the vehicle consists of the following.

a) Fuel tank
b) Fuel strainer or Fuel filter
c) Air cleaner
d) Carburettor

B. *Engine Selection*

P= $F_{resistances}$ x Velocity.

P = 120.616 N x (80 kmph)

P = 9.6493 kW

P = 12.9397 BHP

Thus, engines with power more than 12.9397 BHP were shortlisted.

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Table no.4. Engine specifications

	Honda CB Shine	Bajaj discover 125	Hero Glamour 125	TVS Phoenix	Bajaj Pulsar 150
Displacement	124.7 cc	124.6 cc	124.7 cc	124.53 cc	149 cc
Max. Power	10.57 Bhp @ 7500 rpm	10.9 Bhp @ 8000 rpm	9 Bhp @ 7000 rpm	10.8 Bhp @ 8000 Rpm	13.8 Bhp @8000rpm
Max Torque	10.30 Nm @ 5500 rpm	10.80 Nm @ 5500 rpm	10.35 Nm @ 4000 rpm	10.8 Nm @ 5500 rpm	13.4NM @6000 rpm
Compression Ratio	9.2:1	9.8:1	9.1 : 1	9.4:1	9.5 :1
Bore	52.4	57	52.4	57	57
Stroke	57.8	48.8	57.8	48.8	56.4

C. Transmission Shaft

The Transmission Shaft is designed for the following stresses. The stresses induced in the shaft are:

Shear stresses due to transmission of torque (due to torsion load)

Bending stresses (tensile or compressive) due to the forces acting upon the machine elements like sprocket as well as the self-weight of the shaft.

The weight distribution ratio rear: front = 60 : 40 is assumed.

The rear track width, 940mm, and the mounting positions of the bearings and the engine were obtained from the model of the frame. After this, the forces, bending moment and twisting moments were determined. The shaft diameters were determined for various materials considering their strength, the equivalent bending and torsion moment known.

Keys will be used to achieve positive drive and castle nut and circlips will be used to restrict axial motion.

Weight of kart = 150kg

Therefore, weight on the rear shaft = 0.6*150=97.5 kg

Wheelbase=1070mm Rear Track width = 940mm

Total tractive force on rear wheels = m x g x 0.6 = 882.9 N

Material options: EN8, EN19, EN24, SS316, A106.

D. Mechanical Properties

EN8

Ultimate Tensile Strength= S_{ut} =620MPa Yield Strength= S_{yt} = 323.23MPa

EN19

Ultimate Tensile Strength= S_{ut} =944MPa Yield Strength= S_{yt} = 738MPa

EN24

Ultimate Tensile Strength= S_{ut} =801MPa Yield Strength= S_{yt} = 629.41MPa

SS316

Ultimate Tensile Strength= S_{ut} =515MPa Yield Strength= S_{yt} = 205MPa

A106

Ultimate Tensile Strength= S_{ut} =414MPa Yield Strength= S_{yt} = 241.3MPa

Diameters obtained after calculations (using MS Excel), and their values obtained after rounding off to nearest available bearing diameter for above materials have been tabulated as below.

Table no.10 Material selection for transmission shaft

Material	Theoretical Diameter (mm)	Diameter corrected to available bearing diameters (mm)	Mass (kg)
Solid EN8	29.06	30	5.79
Solid EN19	24.11	25	4.02
Solid EN24	25.465	30	5.79
Hollow SS316	66	70	8.36
Hollow A106	49.13	50	5.789

The weight, diameter and the initial cost of the shaft have to be optimized for good performance/ output.
Thus, EN19 is selected.

V. CONCLUSION

From the design calculations explained in this paper we concluded that selection of suitable material and mechanism for Braking and Transmission system. Power calculations made us select system according to position. Braking system allows stopping the vehicle in minimum distance. From this designing we can conclude different aspects like ergonomics, aesthetics and modelling of Go-kart.

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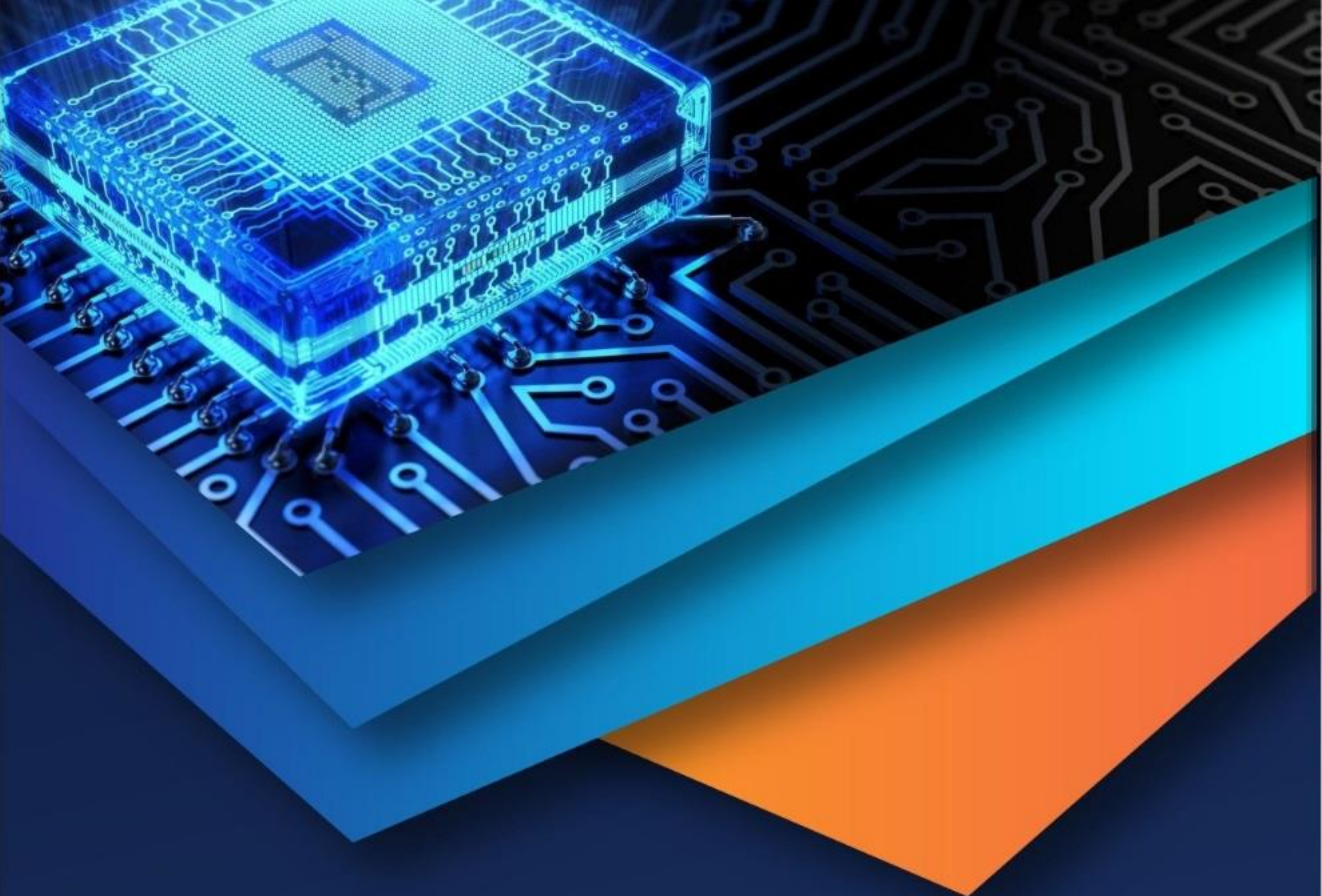
REFERENCES

[1] SatyaPrakash Gupta et.al., "BRAKING SYSTEM DESIGN FOR GO-KART", volume-7, issue-2, february-2018 , print issn no 2277 – 8160
[2] Rajkumar M, et.al., " DESIGN OPTIMIZATION AND ANALYSIS OF BRAKING SYSTEM OF GO-KART"International Journal of Engineering Research & Technology (IJERT) http://www.ijert.org ISSN: International License Vol. 9 Issue 09, September-2020
[3] Raj Kumar Prasad,et.al., "DESIGN OF BRAKING SYSTEM FOR GO-KART" International Journal of Management, Technology And Engineering ISSN NO : 2249-7455
[4] Gurunath C. Kudari.et.al, "DESIGN OF TRANSMISSION SYSTEM FOR GO-KART",Vehicle International Journal of Engineering and Techniques - Volume 4 Issue 2, April-2018.
[5] SatyaPrakash Gupta,et.al., "BRAKING SYSTEM DESIGN FOR GO-KART", volume-7, issue-2, february-2018 print issn no 2277 – 8160
[6] Parvez Hussain S.D.,et.al., "AN INNOVATIVE ENERGY EFFICIENT AUTOMOBILE DESIGN", "International Journal of Innovative Science and Modern Engineering (IJISME).ISSN: 2319- 6386, Volume-2 Issue-10, September 2014. 6. U.S. Department of Energy, Transportation Energy Data Book Edition 2004. July 2006 (visited 15/2/2009).
[7] Caroline M.L., et.al., "GROWTH AND CHARACTERIZATION OF BIS THIOUREA CADMIUM IODIDE: A SEMIORGANIC SINGLE CRYSTAL", Materials Chemistry and Physics, ISSN : 0254-0584, 113(Feb-3) (2009) pp. 670-674.
[8] Mes Paolino,et.al., "THE S-90 GO-KART -OPTIMAL DESIGN REPORT", NSF Projects. Ashford.
[9] Dave Agler,et.al., "HUMAR POWER- HPV DESIGN CONSIDERATIONS", The Technical Journal of the IHPVA Volume 4, No. 4, fall 1985.



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