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Designing and Structural Analysis of Go-Kart by PTC CREO & Ansys tool

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Abstract: This report presents the design and structural analysis of a go-kart using PTC Creo for CAD modelling and ANSYS for finite element analysis (FEA). The aim is to develop a low-cost, comfortable, and durable go-kart with an optimized frame design. The study involves the application of design principles and advanced simulation tools to ensure the go-kart meets safety and performance standards. The best frame design was identified through iterative testing and analysis, focusing on weight distribution, material selection, and structural integrity. The objective of this work is to demonstrate the design procedure and good strength for a Roll cage. This project emphasizes on the practical and engineering applications of the subjects Vehicle Dynamics and Automotive Technology.

Keywords: Golf Kart, PTC CREO, ANSYS, Chassis Frame Analysis.

I. INTRODUCTION

As per the name a Golf Kart is designed to run and maneuver on different terrains or in other words, we can say that a Golf kart is designed especially for off-roading purpose. In off-roading conditions, we come across various loads which are finally transmitted to the frame. Frame is most important part of an automobile as all mountings and assemblies are done on frame itself, so it becomes necessary for a Go-Kart frame to sustain both static and dynamic loads. In this study we have put forward a proper methodology for designing and analyzing the frame before the Go-Kart is tested on vigorous terrains and conditions. Various types of frames are used depending on the type of loading which they will undergo, for example a ladder frame is used in heavy commercial vehicles where load has to be transferred from one place to another, similarly there are other types such as monocoque, ULSAB, tubular space frame etc. among these tubular space frames is one which we have considered for designing our Go-Kart because it provides multi-directional impact safety as well as it is easier in fabrication.

II. LITERATURE REVIEW

1) Shaik Him am Saheb, Rav Sandeep Kumar Kona, Md. Hameed, July – August (2016) in IJEAST, the design and construction for GO-KART DESIGN CHALLENGE 2015 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 and analysis of our vehicle The making of this report has helped us in learning of various software. We want to give a vote of Thank you in this regard as GKDC competition has given as this opportunity to learn many things which will also help us in leading a bright future.
2) Anjul Chauhan, Lalit Naagar, Sparsh Chawla, September (2016), We used the finite element analysis system to evaluate, create, and modify the best vehicle design to achieve its set goals. The main goal was to simplify the overall design to make it more light-weight without sacrificing performance and durability. The result is a lighter, faster, and more agile vehicle that improves go kart design.
3) Sandip Godse D. A. Patel et. Al (2012). Chassis is a major component in a vehicle system. This work involved static analysis to determine key characteristics of a chassis. The static characteristics include identifying location of high stress area. Mathematical calculations were carried out to validate the static analysis.
4) K. Rajasekar, R. Saravanan P [7] et. Al Chassis is the most important structural member in the On-Road vehicles. In order to overcome more failure in the chassis structure and ensure the safety, the variable section chassis structure must be designed based on the variable loads along the length of the vehicle. The present study reviewed the literature on chassis design and presented the findings in the subsequent sections.

5) Sangeetha Krishnamoorthi, L. Prabhu, MD Shadan, Harsh Raj, Nadeem Akram, September (2020), The material AISI 1018 was selected for chassis frame and the overview of choosing this material was provided awfully. The effect of the impact test done on front, side and rear was provided to understand the total deformation occurred in each case. Since the use of electric vehicles is gaining more attention, this paper gave the detailed analysis of the values obtained while using the electric motor in the Go Kart. The speed achieved by using the motor was about 59.32 km/hr, with a driving force of 121.25 N and acceleration of 0.93 m /s_2. Since the future is bright for electric vehicles as the world is shifting to renewable energy from non-renewable ones.

III. MATERIAL SELECTION

Low-cost roll cage was provided through material selection and incorporating more continuous members with bends rather than a collection of members welded together to reduce manufacturing costs. One of the key design decisions of our frame that greatly increases the safety, reliability and performance in any automobile design is material selection. While selecting the material there are some limitations.

AISI 1018 is selected for the chassis because of the following reasons
1) Machinability
2) Weld ability
3) Availability

These limitations include the method of fabrication and industry standards for the material. AISI 1018 iron pipe has been used to make the roll cage. The base of the entire vehicle is based on the roll cage; hence it must be made very strong. The frame will be built using a bent tube construction and ARC welded joints. ARC welding becomes difficult at wall thicknesses less than 0.035 inches. The tubing bender that will be used for the fabrication can bend a maximum of 1.5-inch diameter tube with a 0.120-inch wall thickness. there should be at least 0.18% of carbon content in metal. Our initial step was to conduct a market survey to have an idea of the availability of the material. Based on market survey we have chosen following material namely: - AISI 1018 steel having the properties as given below:

Table (a) Material Property

Material AISI 1018		
Property	Value	Units
Density	7870	Kg/m^3
Young`s Modulus	2.0124e+005	Mpa
Poisson`s Ratio	0.29	
Bulk Modulus	1.5971e+.005	Mpa
Shear Modulus	78000	Mpa
Tensile Yield Strength	370	Mpa
Tensile Ultimate Strength	440	Mpa

A. Pipe Size Selection

The pipe length is 88.5 inch and height 59 inch. AISI 1018 pipe thickness 4 mm and outer diameter 25 mm this pipe total weight 63 kg.

Table (b) Pipe size Details

S. No	Pipe	Dimension
1.	Thickness	4 mm
2.	Length	88.5 in
3.	Height	59 in
4.	Width	46.5 in
5.	outer Diameter	25 mm
6.	Total Weight	63 kg

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IV. DESIGN METHODOLOGY

The process of developing the chassis frame, a proper design method is employed. The conceptual design is first developed using sketches. Then, design and analysis of the Golf-Kart chassis and components are performed using PTC CREO Parametric 10.0.1.0 software. A mechanical framework, also known simply as a frame or chassis, is a structure composed of interconnected members designed to support or contain mechanical components. These components could include machinery, equipment, vehicles, or other systems where structural integrity is crucial. mechanical frameworks play a critical role in providing the necessary structural support and stability for various mechanical systems, ensuring their functionality, safety, and longevity.

The following design methodology was used during design:

1) Requirements
2) Design calculations and Analysis
3) Considerations
4) Testing
5) Acceptance

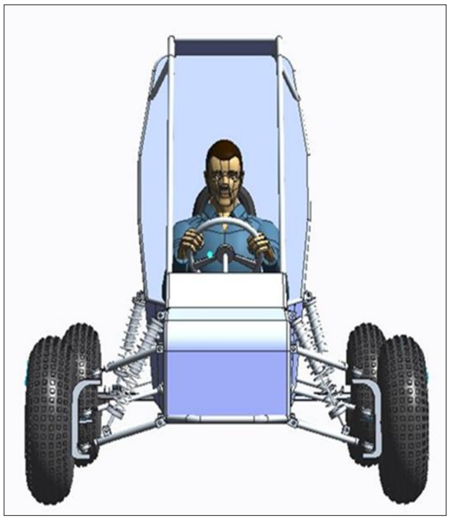

Fig. 1 Front View

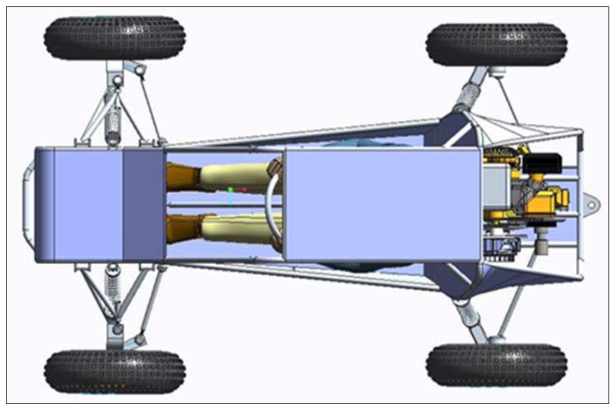

Fig. 2 Top View

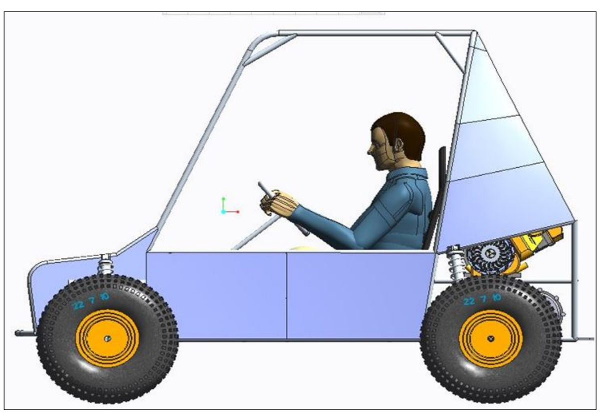

Fig. 3 Side View

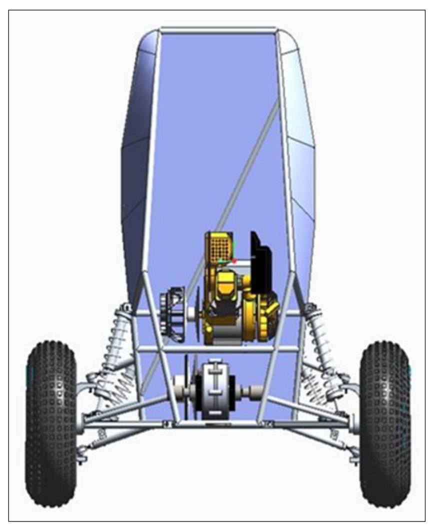

Fig. 4 Back View

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Fig. 5 Isometric View

It is important that the results of the analysis satisfy the technical requirement of the vehicle. Necessary modifications to the design need to be undergone if the analysis yields negative results. After all the process was completed, only then the fabrication of the frame was then conducted.

V. FRAME ANALYSIS

The stress analysis of the chassis has been done by taken different load using ANYSY R15.0 software and The PTC CREO software is used for the modeling of chassis and components designs and then it was imported to ANSYS R1. From the results all designs having factor of safety under 3.88. from this result, the designs are believed to be safe enough to be fabricated. For the purpose of analysis, we have conducted Certain Tests on the Chassis, which are: -

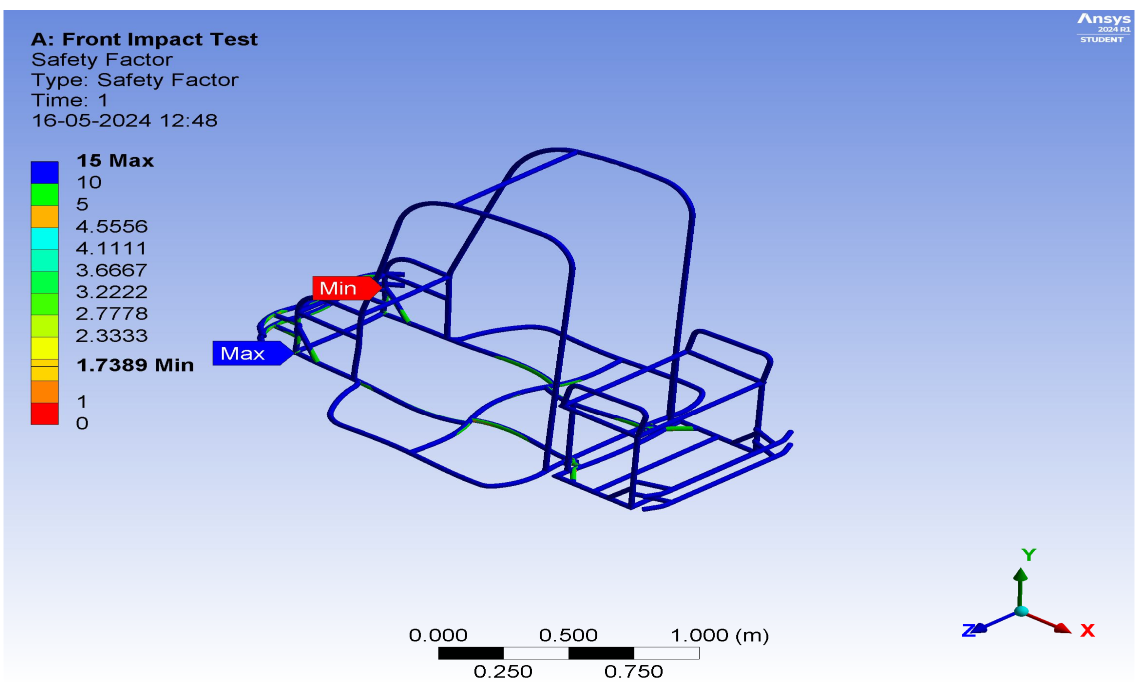

Fig. 6 Front Impact Test 4G

1) *Front Impact Test*

The Front Impact Analysis has been carried out on the Ansys 15.0 while constructing a perfect space frame tubular chassis on Creo 2.0 Surface module. and then it was imported to ANSYS R1.

A force of 16000 N was applied to the front ends constraining the body panel rods and we had seen such results as shown above and assuming the deceleration

$$FOS = \frac{\text{Yield Strength of AISI 1018}}{\text{Von-Mises Stress}}$$

So, FOS = 370 / 212.78

FOS = 1.7389

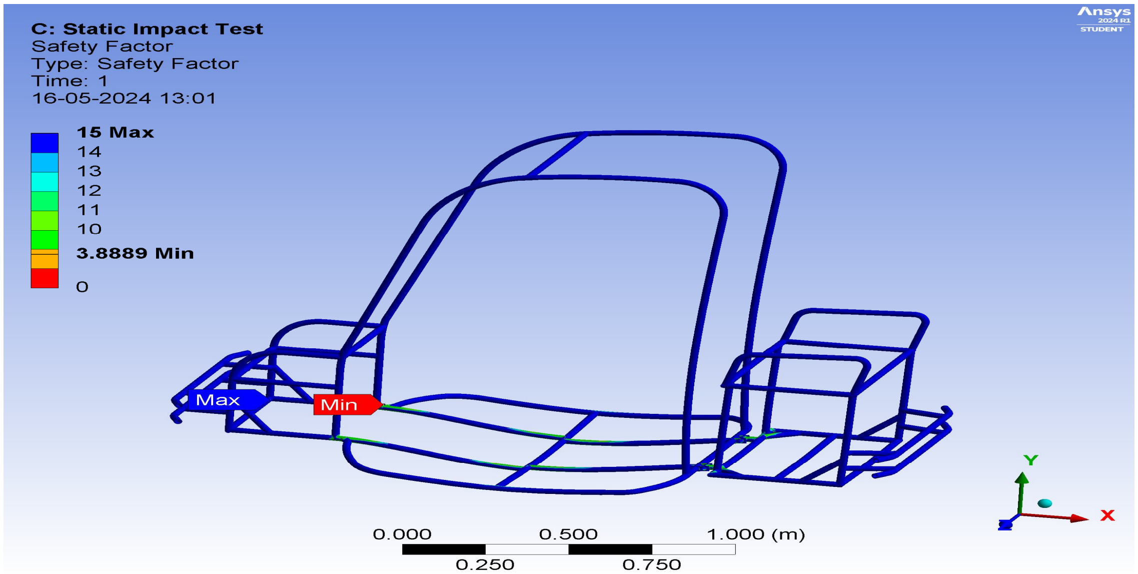

Fig. 7 Rear Impact Test 4G

2) Rear Impact Test

A force of 16000 N was applied to the rear ends by totally constraining the degree of freedom of the suspension points and we had seen such results as shown and assuming the deceleration of 4G.

$$FOS = \frac{\text{Yield Strength of AISI 1018}}{\text{Von-Mises Stress}}$$

So, FOS = 370 / 236.92

FOS = 1.5617

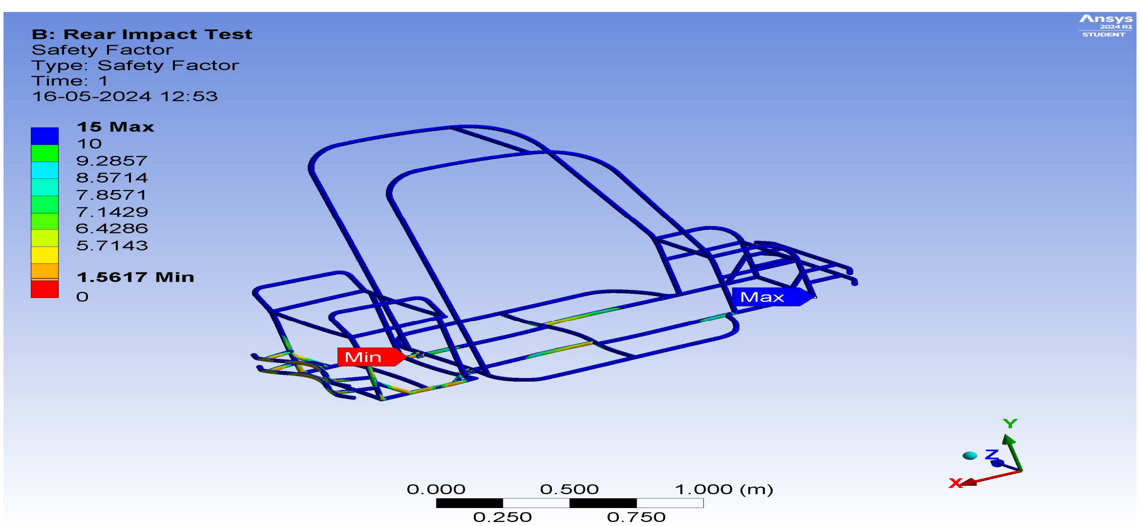

Fig. 8 Static Impact Test 1G

3) Static Impact Test

A force of 4000 N was applied to the front ends constraining the body panel rods and we had seen such results as shown above and assuming the deceleration

$$FOS = \frac{\text{Yield Strength of AISI 1018}}{\text{Von-Mises Stress}}$$

So, FOS = 370 / 95.14

FOS = 3.8889

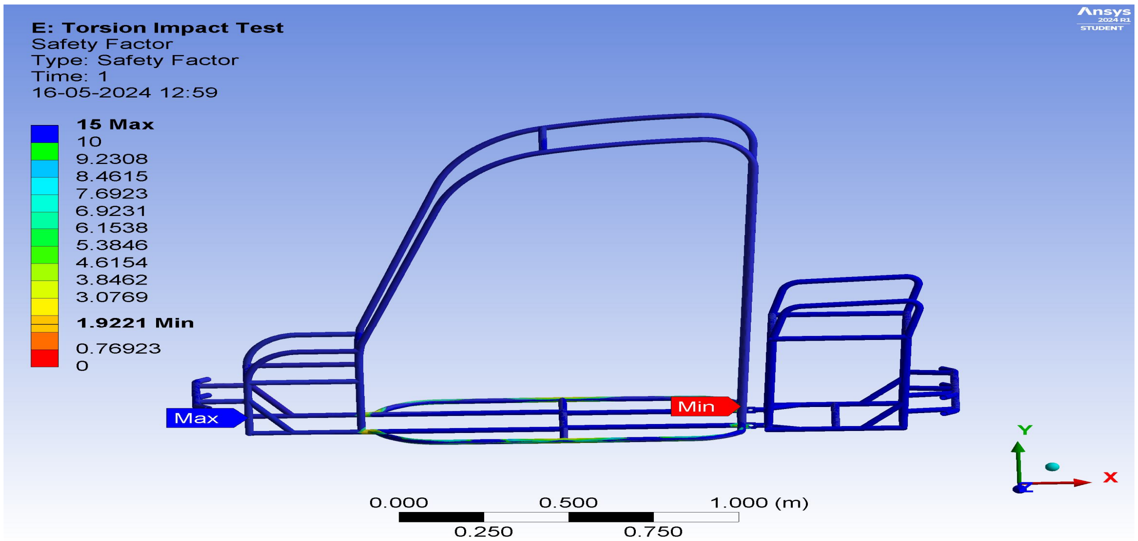

Fig. 9 Side Impact Test 3G

4) Side Impact Test

The Side Impact Analysis has been carried out on the Ansys 15.0 while constructing a perfect space frame tubular chassis on Creo 2.0 Surface module and then it was imported to Ansys R1 with a Force with respect to the 3G criteria

$$FOS = \frac{\text{Yield Strength of AISI 1018}}{\text{Von-Mises Stress}}$$

So, FOS = 370 / 199.85

FOS = 1.8514

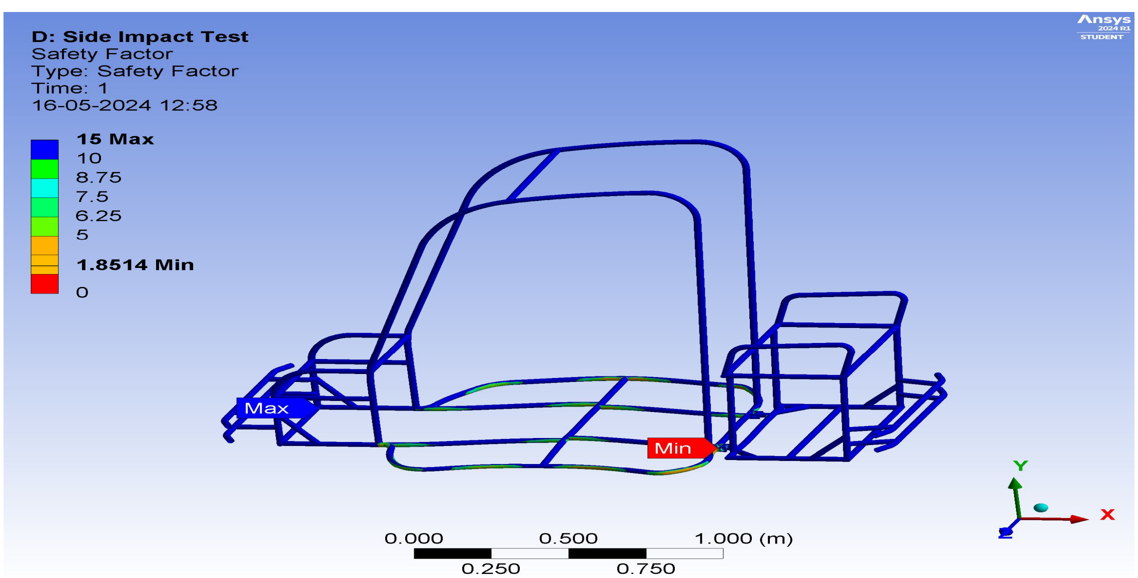

Fig. 10 Torsion Impact Test 4G

5) Torsion Impact Test

A force of 4000 N was applied to the front ends constraining the body panel rods and we had seen such results as shown above and assuming the deceleration

$$FOS = \frac{\text{Yield Strength of AISI 1018}}{\text{Von-Mises Stress}}$$

So, FOS = 370 / 192.5

FOS = 1.9221

VI. RESULT AND DISCUSSIONS

The analysis of design determines the stresses developed in the chassis which plays an important role in factor safety. From the analysis we can predict the chassis is safe or not and also by seeing the deformation and stresses modification in the kart chassis is possible.

Table (c) ANALYSIS RESULTS

S. no	Test Name	Stress	Safety Factor	Deformation
1.	Front Impact Test 4G	212.78 M.pa	1.73	1.11 mm
2.	Real Impact Test 4G	236.92 M.pa	1.56	2.35 mm
3.	Side Impact Test 3G	199.85 M.pa	1.85	1.96 mm
4.	Static Impact Test 1G	95.14 M.pa	3.88	1.82 mm
5.	Torsion Impact Test 4G	192.5 M.pa	1.92	3.34 mm

VII. CONCLUSIONS

The golf kart is fabricated within allowable budgets. The designs have been validated by stress analysis using available Catia and Ansys Software. The development of the golf kart has established design for manufacturing practice. With further development and research, the golf kart is subjected for improvement. The sustainability of the design and development of the golf kart depends on the material selection, design criteria and components availability. The design of the vehicle is kept very simple keeping in view its manufacturability. Thus, at this point of time our vehicle design can be predicted to heading in correct direction. There is a lot of future work which is essentially required to fine tune the performance. The design, development and fabrication of the roll cage is carried out successfully. The roll cage is used to build a golf kart by integrating all the other automotive systems like transmission, suspension, steering, brakes and other miscellaneous elements.

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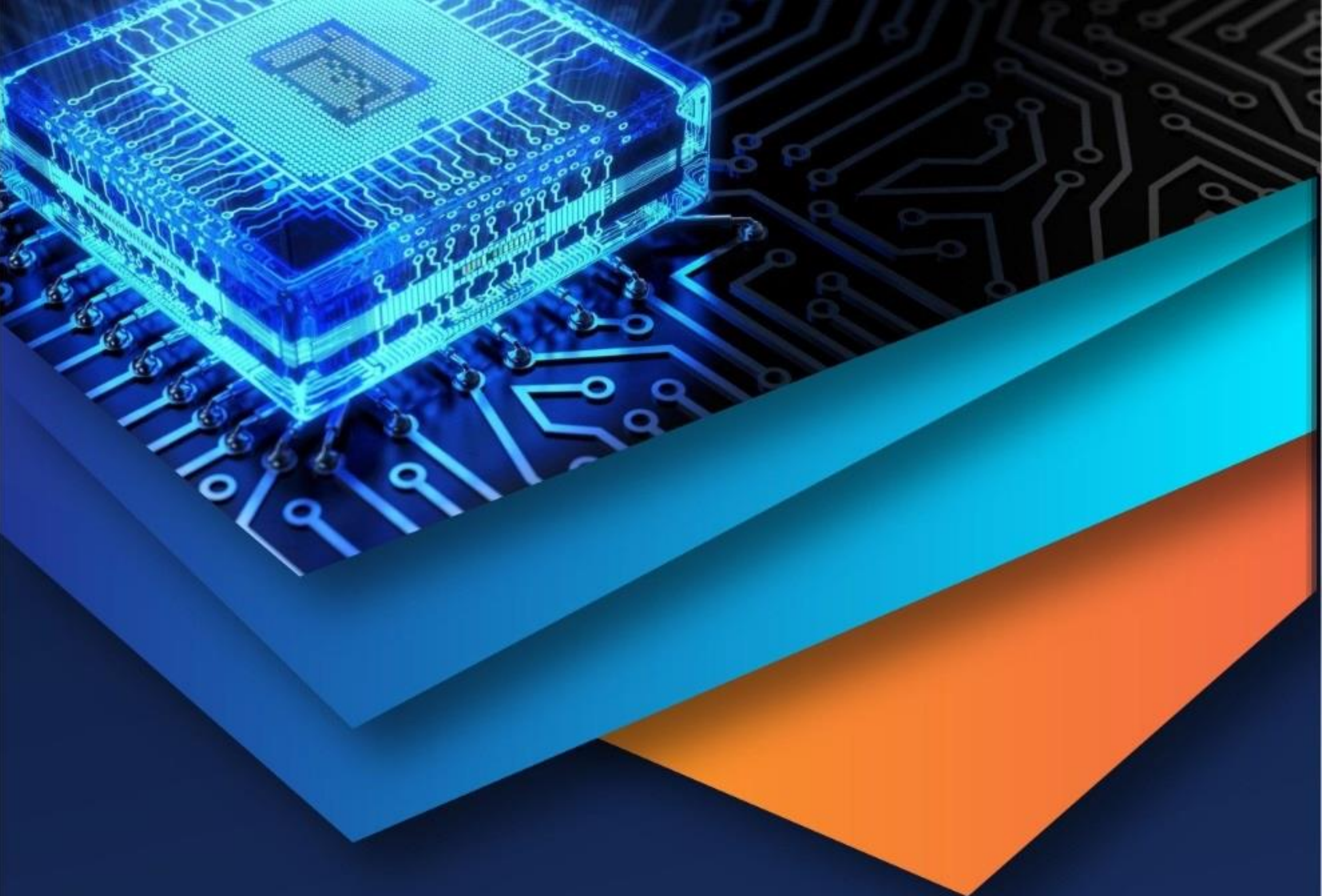

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