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Design and Analysis of Electric Go-Kart Chassis

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Abstract : This paper aims to the design analysis of a go kart chassis. The main intention is to do modeling and static analysis of go-kart chassis. The maximum deflection is obtained by analysis. The go-kart chassis are different from chassis of ordinary cars on the road. The paper highlights the material used and structural formation of chassis. The strength of material, rigidity of structure and energy absorption characteristics of chassis is discussed. The modeling and analysis are performed using 3-D software such as SOLIDWORKS, ANSYS and HYPERMESH. The loads are applied to determine the deflection of chassis.
Keywords: Go-kart, Chassis Design, Solid works, Ansys, Impact Forces, Analysis

I. INTRODUCTION

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 & modeling them in CAD software like CREO Parametric 2.0 and subjected to analysis using ANSYS 15.0 FEA software. Based on analysis result, the model was modified and retested and a final design was frozen. The design process of the vehicle is iterative and is based on various engineering and reverse engineering processes depending upon the availability, cost and other such factors. So the design process focuses on following objectives: Safety, Serviceability, Strength, ruggedness, Standardization, Cost, Driving feel and ergonomics, Aesthetics. The design objectives set out to be achieved were three simple goals applied to every component of the car: durable, light-weight, and high performance, to optimizing the design by avoiding over designing, which would also help in reducing the cost. With this we had a view of our kart.

This started our goal and we set up some parameters for our work, distributed ourselves in groups for the technical design of our vehicle.

II. CHASSIS

A. Introduction

In the case of vehicles, the term CHASSIS can be described as the frame which supports all the components of the vehicle. The wheels of the vehicle are mounted on the chassis with the help of king pin and sprockets and the other parts are also attached with bolts and welding process. The chassis should be rigid from all the Bending and Torsion stress. To ensure the safety of the driver the chassis should be designed to comply with basic safety rules and at the same time serve its purpose.

B. Goals

To ensure safety of the driver.
To maintain low center of gravity.
To ensure that all the systems fit onto the chassis
To design a chassis with high strength and low weight.

C. Our design specifications

Wheelbase: 1474.4mm
Track width 70%. Of the wheelbase (1032mm)
Overall length: The overall length of the vehicle is 1830mm excluding the front and rear bumpers
Difference between the front track width and rear track width is less than 20%
Roll Bar is used in the structure and its top is extended over the driver’s helmet.

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TABLE.I
SPECIFICATIONS

Overall length (mm)	1830
Chassis skeletal weight (kg)	25
Width (mm)	1016
Height (mm)	88.24
Wall thickness (mm)	1.2
Weight distribution	40:60
Total weight (kg)	130

III. MATERIAL SELECTION

Cost, availability, weight, strength & weld ability are the four key factors which determine the material selection. Proceeding from these factors, the following material was chosen as the most suitable one for the kart.

TABLE.II
MATERIAL COMPOSITION OF STAINLESS STEEL 304 SEAMLESS PIPES

Component	C max	Cr	Fe	Mn	Ni	P Max	S Max	Si Max
Weight %	0.08	18-20	66.34– 74	Max 2	8-10.5	0.045	0.03	1

A. Material Specification and process

Material selected as per the rule book

The most common material for tubular space frames retains its strength and ductility after welding.

It is inexpensive, easy to weld, and easily available. The material has good mechanical properties which suits the requirements othe kart.

SS 304 has all the mechanical properties needed to make a go-kart chassis

The material will be cut as per the required dimensions and then welded

Welding TIG weldin is used to weld the chassis. Stainless steel fillets will be used for the welding process.

TABLE.III
PROPERTIES OF MATERIAL

Density (kg/m^3)	8000
Yield strength (MPa)	205
Ultimate strength (MPa)	505
Young modulus (MPa)	193000
Poisson’s ratio	0.29
Factor of safety	1.8

B. Bumper Material

The material used for the bumpers is carbon fiber.

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C. Solid Modeling

After carefully reading and understanding the design parameters, the basic design of the chassis was decided. After incorporating steering mounting points and engine mounting considerations, the team has carried out several iterations to decide support members and compliance of the same has been verified and the chassis has been finalized.

IV. 3D MODELLING AND ANALYSIS

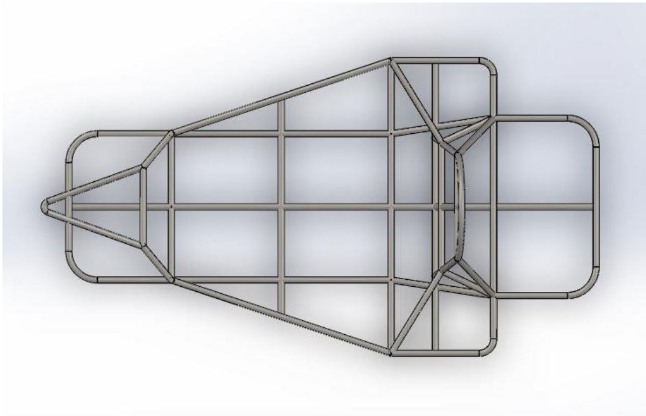

Fig.1 Top view of chassis

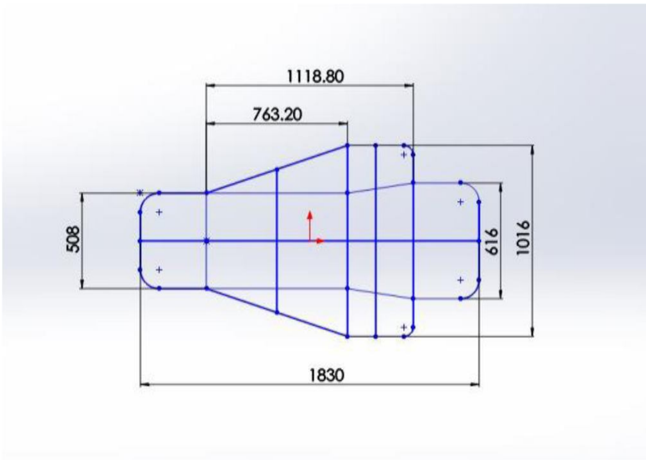

Fig.2 Top view with dimensions

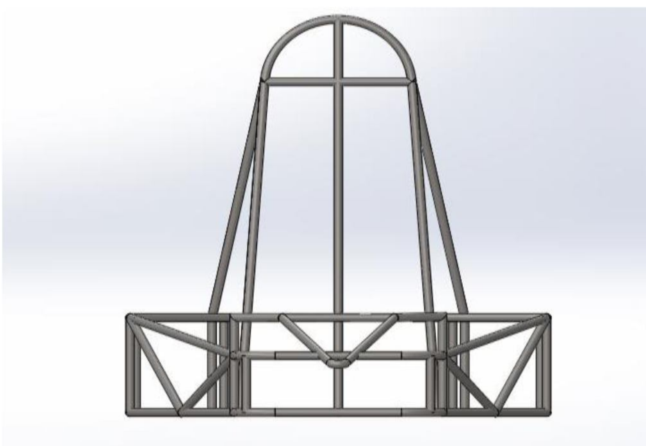

Fig.3 Front view

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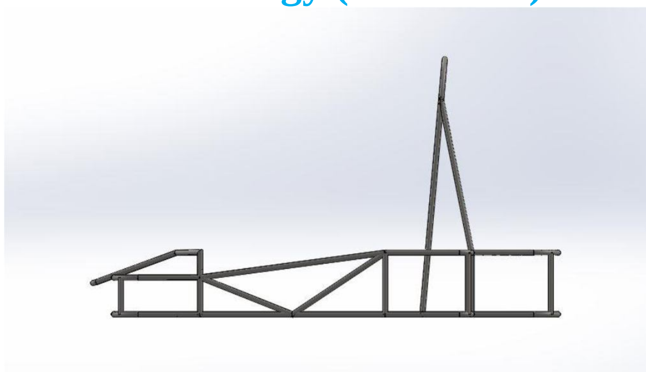

Fig.4 Side view

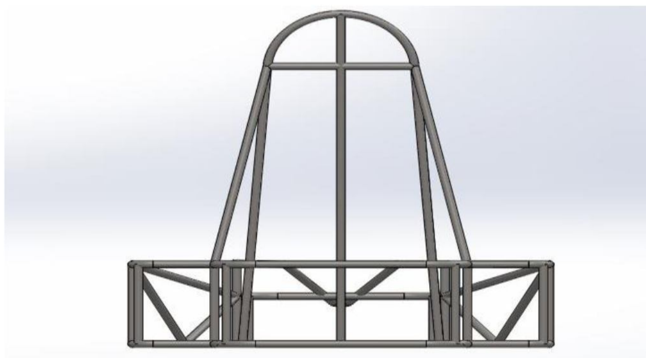

Fig.5 Rear view

A. Analysis

Structure, after designing must be validated to know its reliability. Conventionally in FEA, the frame is subdivided into elements. Nodes are placed where tubes of frame join. The assumption made in using beam elements is that the welded tubes have stiffness in bending and torsion, thus a higher factor of safety is desirable

Frontal Impact Frontal impact has been done by considering the kart going at its maximum possible top speed of 70kmph and undergoing a head collision with a rigid body.

B. Calculations

Mass of the kart including driver, m=250kgs =2452.5N

Maximum velocity, v= 76kmph

T=0.1s time taken from top speed to stop F= mv/t

= 2452.5x21.11/0.1=517722.75N

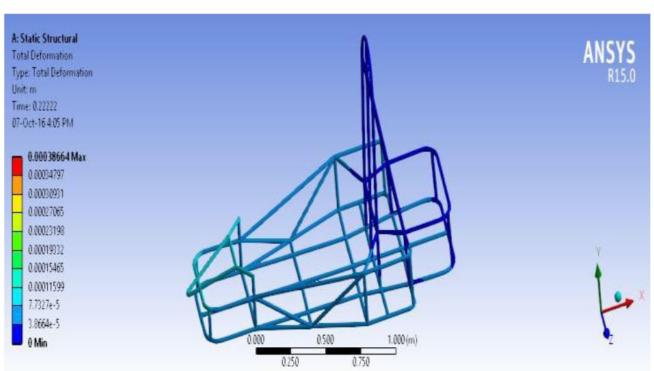

Fig.6 Deformation during frontal Impact

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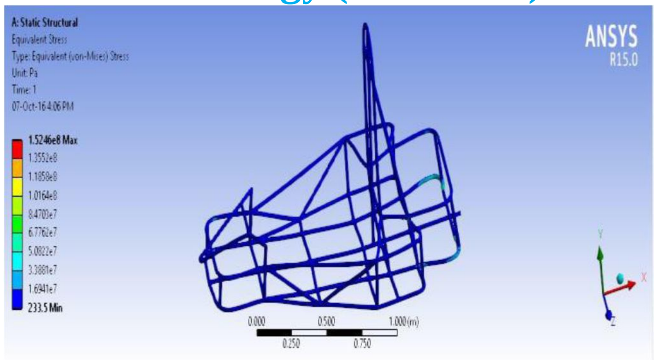

Fig.7 Stresses during Frontal Impact

TABLE.IV
RESULT OF FRONT ANALYSIS

Load applied (N)	4800
Maximum deformation (m)	0.0003866
Maximum stress (MPa)	142.56
Factor of safety	3

Rear Impact The rear impact analysis has been done by considering the kart getting hit by another vehicle at its top speed. The force calculations are same as that of front impact.

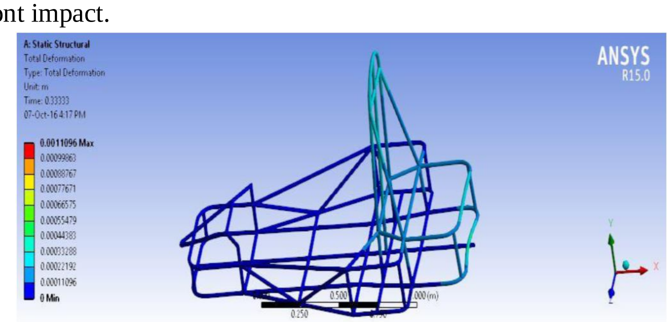

Fig.8 Deformation during rear impact

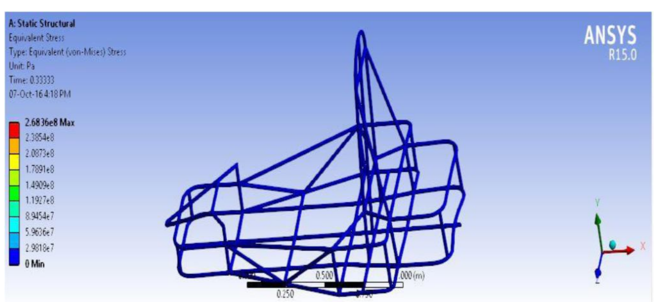

Fig.9 Stress during rear impact

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TABLE.V
RESULT OF REAR ANALYSIS

Load applied (N)	4800
Maximum deformation (m)	0.00110
Maximum stress (MPa)	268.36
Factor of Safety	3.7

C. Torsion

In order to calculate the torsional rigidity of the chassis during cornering, a moment due to the lateral weight transfer was considered

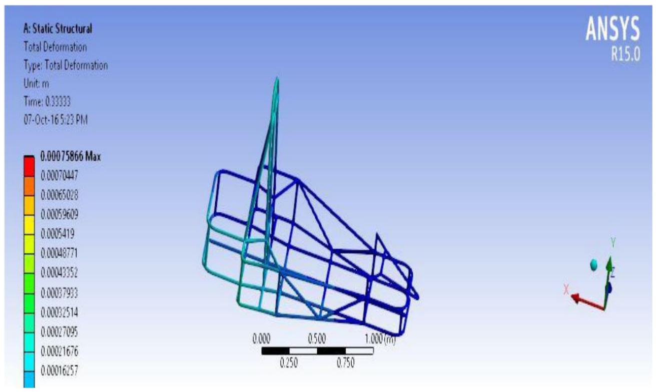

Fig.10 Deformation on right side during torsion

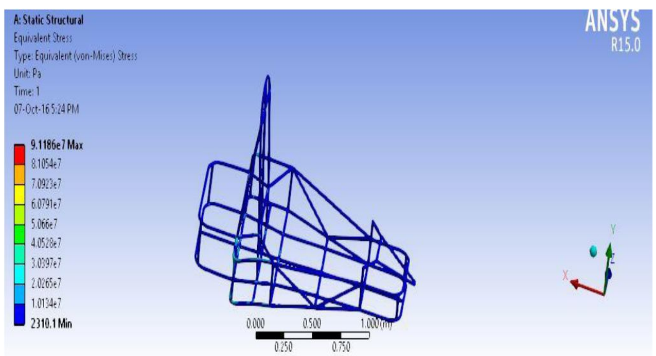

Fig.11 Stress on right side during torsion

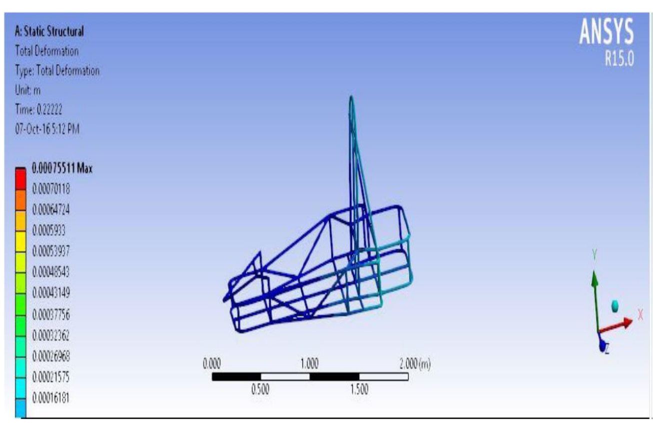

Fig.12 Deformation on left side during torsion

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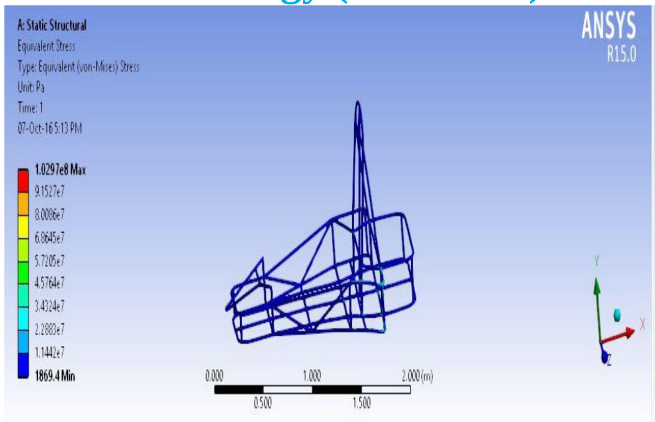

Fig.13 Stress on left side during torsion

TABLE.VI
RESULT OF LEFT & RIGHT SIDE ANALYSIS

Parameters	Left Side	Right Side
Load applied N	3600	3600
Max. Stress right side (tension & compression) (MPa)	91.186	102.97
Maximum displacement right side (m)	0.00075866	0.000755
Factor of safety	2.8	3

D. Prototype

This prototype was made to better understand the design of the chassis

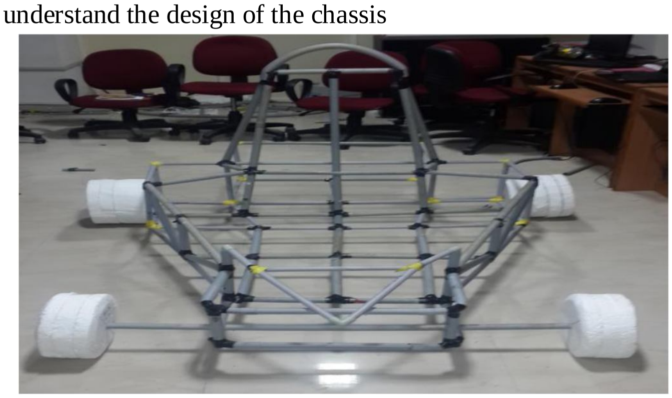

Fig. 14 Front view of prototype

Fig. 15 Side view of prototype

V. CONCLUSIONS

The designing of chassis for go-kart can develop many skills. The learning of 3-D modeling software like Solid works is essential to obtain desire design. 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.

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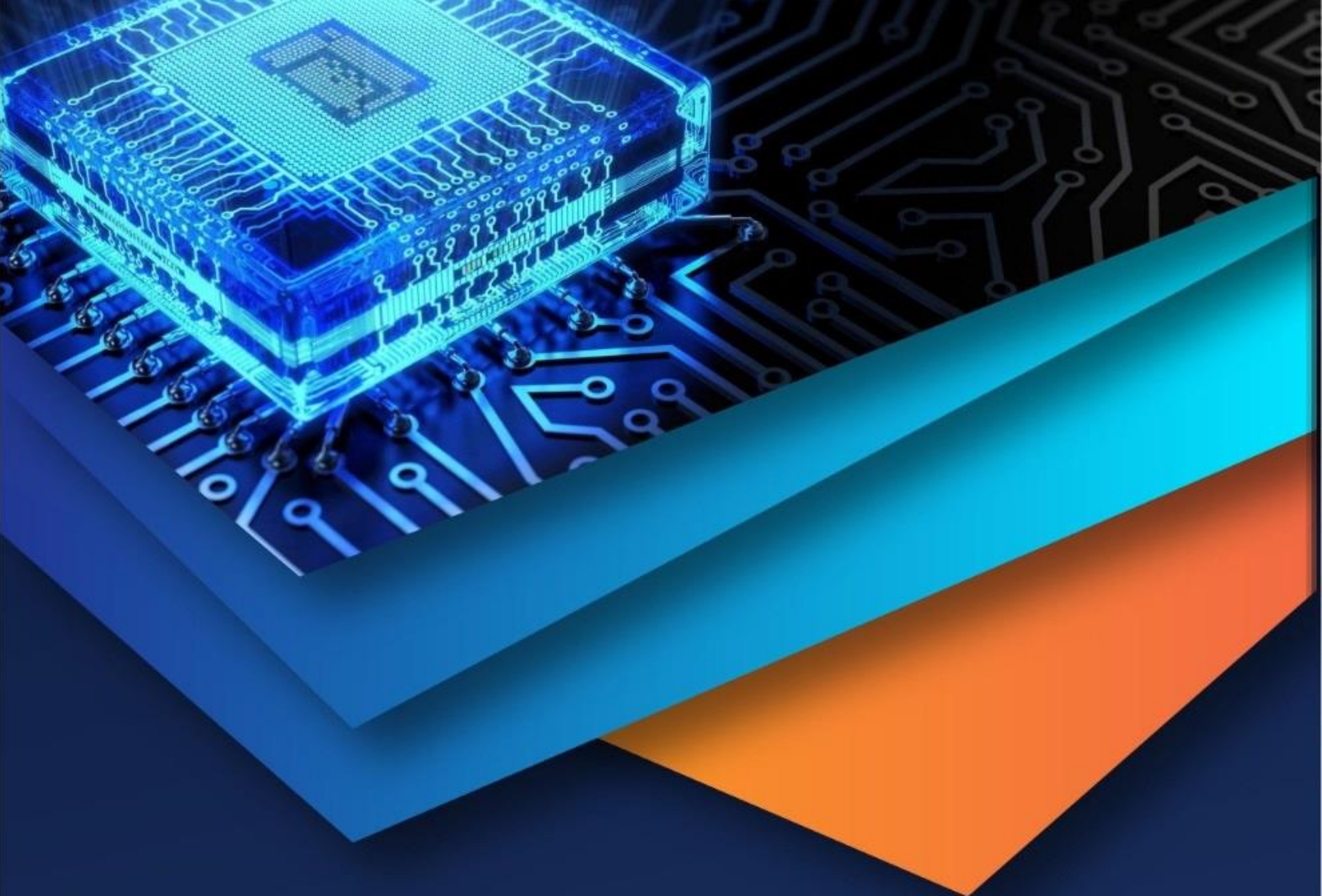

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