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Design and Fabrication of Multipurpose Mechanical Machine

S. Muruganantham[1], S. Aravind[2], S. Gowtham[2], M. Harishankar[2], S. Nithiskumar[2]
[1]*Assistant Professor,* [2, 3, 4, 5]*UG Scholar, Department of Mechanical Engineering,Erode,Tamilnadu, INDIA*

Abstract: ***Multi-Purpose Mechanical Machine is widely used in production based industries. Industries are producing useful products and services for the products with low production cost, machinery cost and also low inventory cost for the production of products. Due to development in technology all the process and tasks are made faster, quicker and safer. But this advancement in technology needs huge investment and also industry needs to achieve high production rate and maintaining the quality with low average cost.***
We have developed a model of the machine which can perform three different operations such as cutting, grinding and drilling simultaneously.
In this machine we are giving drive to the main shaft to which bevel gear mechanism is directly attached; on the main shaft we have use bevel gear system for power transmission to three locations. Through bevel gear we will give drive to drilling centre, cutting centre and grinding centre.
The model facilitates us to perform operations at different working centre simultaneously as it is getting drive from single power source.
The main objectives of this prototype are, conserving the electricity, reducing the manpower, increasing high production rate, and mainly to reduce the floor space occupied by the machine.
Keywords: Bevel gear, Cutting wheel, Drill bit, Grinding wheel.

I. INTRODUCTION

This concept concerns the design, development and manufacture of the “Multi purpose Mechanical Machine”. The concept of multipurpose mechanical machine is mainly used for industries.
The industries are basically destined for the production of goods and services useful at low production costs, machine costs and low inventory costs.
Today in this world, every activity has become faster and faster due to technological progress, but this progress also requires huge investments and expenses. Each industry wants to achieve a high productivity rate while maintaining the quality and standard of the product at a low average cost.
In a sector, a considerable part of the investment is made for the installation of machinery. So in this project a work is proposed in which a machine is designed to capable of performing operations such as drilling, cutting, grinding operations at different work centers simultaneously, which implies that the industrial will not have to pay more for the machine.

A. Drilling

Drilling is a mechanical process widely used in the industry that uses a drill bit to make a hole in circular shape on solid materials. Drill bit is a circular cutting tool and also a multipoint tool.

B. Cutting

Cutting is the process which is used to cut the solid particles into two are more parts by applying force on the object. The process will perform only when the total stress generated by cutting exceeds the ultimate strength of the object which is going to be cut out.

C. Grinding

Grinding is the machining process which uses the abrasive wheel to perform the operation. Grinding is used to finishing the work pieces with high surface quality and to obtain high accuracy level in shape and dimension.

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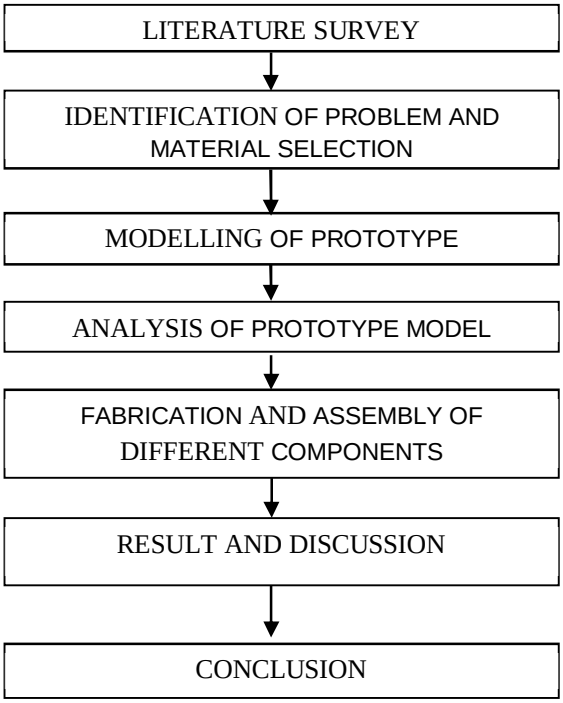
II. METHODOLOGY



III. LITERATURE SURVEY

The extensive literature review will help to understand the concepts, the theorems and the different factors that influence the machines performance. Before starting our work we had viewed many research papers which indicates that for a production based industries machines installation is a crafty and a skillful task as many fact or are associated with it such as power consumption, time required, maintenance cost, number of units produced per machine etc.

Multiple mechanical operations such as, Drilling, cutting, grinding, shaping are performed in this single machine with different work centers. Bevel Gear Mechanism and Scotch Yoke Mechanism is widely used for running the operations. Electric Motor is used for the power supply. A. C. Motor is widely used for the running the machine. Dimension specification of the frame model is cleared from the studied journal papers. Selection of materials for the frame and shaft is cleared for better performance of the machine.

IV. PROBLEM IDENTIFICATION

A. Specification Of The Problem

In the current scenario, the machines are electrically operated. Therefore, we had the idea of the multi-purpose machine able to perform operations such as cutting and grinding and with that we included a drill with the help of a bevel gear. This is actually a conceptual model which can be helpful for small scale industries to raise productivity and can be successfully implemented there. This machine performs multiple operations with constant speed by using the motor which is run by electric power. This machine is based on the bevel gear mechanism. This model of the multi-purpose machine may be used in industries and domestic operation which can perform mechanical operation like drilling, cutting and grinding.

B. Objectives

1) The aim of the proposed system is to develop a machine which performs various mechanical operations (Drilling, Cutting, and Grinding) with different work centres simultaneously.
2) To reduce the floor space area in the industry which is to be occupied by the machine.
3) To reduce the consumption of time period for manufacturing a product which involves multi operations.
4) To reduce the man power while performing various operations.
5) To reduce the initial investment for machines by the manufacturers.
6) To develop a compact, portable and economical machine for the manufacturers.

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V. MATERIAL SELECTION

For structural design it is important to consider all materials appropriate to the application. For the design of this multipurpose machine, the material should be cost effective and capable of providing the required properties of each application.
For the frame, the material selection was completed using stress analysis, strain analysis and displacement analysis based on the required stresses that will be applied by lift and drag forces. It was determined that the material should have the following attributes.

A. Suitable strength to weight ratio
B. Rigid
C. Able to withstand calculated stresses and strain
D. Weather resistant
E. Fatigue resistant
F. Smooth surface finish to avoid accidents while performing operations.

Materials that were considered were steel, aluminium and composites. Aluminium can be immediately rejected due to ability to withstand heavy load. Steel would be satisfying the weight requirement. Some types of composites that can be neglected due to higher cost. So, finally Steel was determined to be optimal for this application.

VI. DESIGN PROTOTYPE

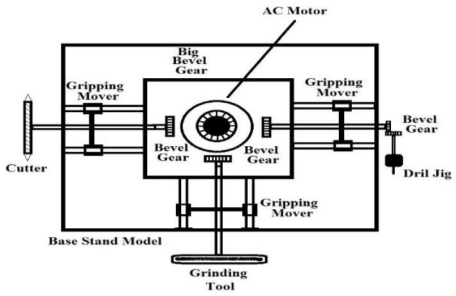

Fig. 1. 2D design

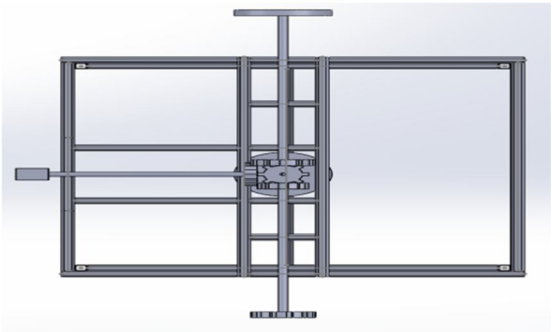

Fig. 2.Top view

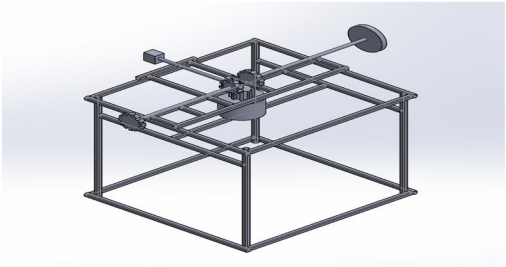

Fig. 3. Isometric view

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VII. DESIGN CALCULATION

A. Frame and Its Specifications

1) Length of the frame = 760 mm
2) Breadth of the frame = 700 mm
3) Height of the frame = 680 mm
4) Frame rod = 1 inch

B. Shafts and Its Specifications

1) Length of shaft with cutting wheel = 480 mm
2) Length of shaft with drill bit = 460 mm
3) Length of shaft with grinding wheel = 420 mm
4) Diameter of the shaft = 12 mm

C. Bevel Gears and Its Specifications

1) No. of teeth in driver gear connected to motor = 10Nos.
2) No. of teeth in driven gears connected to shaft = 16Nos.
3) No. of teeth in driver gear connected to shaft of drill chuck = 20Nos.
4) No. of teeth in driven gear connected to drill = 20Nos.

VIII. SPEED CALCULATIONS

A. Shaft Speed

Speed of driver gear (NG) = 1440 RPM
No. of teeth in driver gear (TD) = 10 Nos.
No. of teeth in driven gear (Td) = 16 Nos.
Velocity ratio (VR) = TD/Td
= 10/16= 0.625
Speed of driven gear (Ng) = VR×NG
= 0.625×1440
= 900 RPM

B. Drilling Speed

Speed of driver gear (NG) = 900 RPM
No. of teeth in driver gear (TD) = 20 Nos.
No. of teeth in driven gear (Td) = 20 Nos.
Velocity ratio (VR) = TD/Td
= 20/20= 1
Speed of driven gear (Ng) = VR×NG
= 1×900
= 900 RPM

IX. DESIGN ANALYSIS

A. Stress Analysis

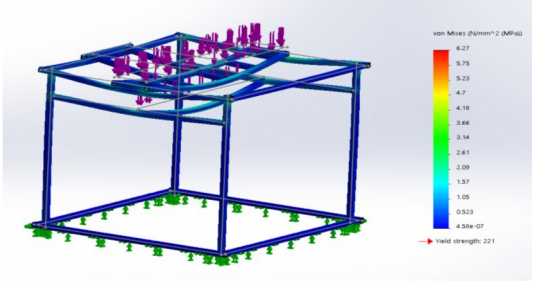

Fig. 4. 3kg Stress analysis

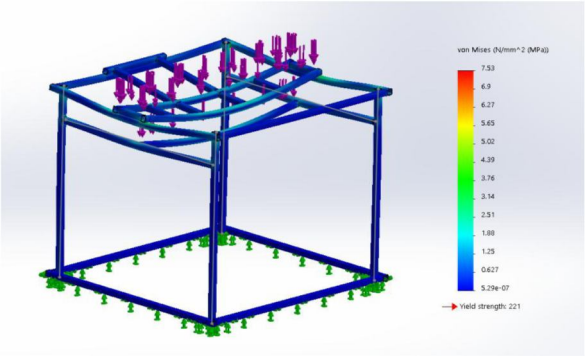

Fig. 5. 4kg Stress analysis

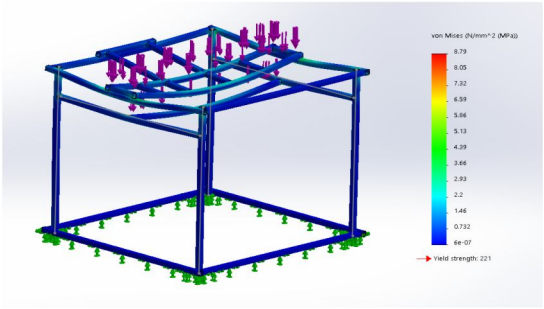

Fig. 6. 5kg Stress analysis

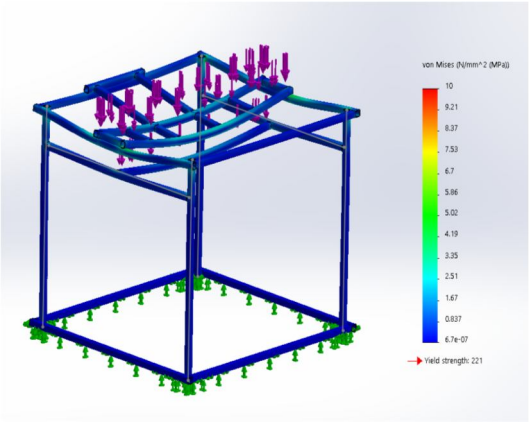

Fig. 7. 6kg Stress analysis

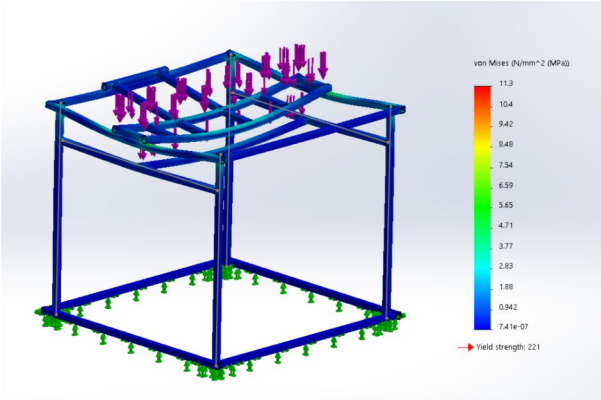

Fig. 8. 7kg Stress analysis

Table 1 :Stress Analysis

Load Applied (Kg)	Stress Induced (N/mm^2)
3kg	6.27
4kg	7.53
5Kg	8.79
6kg	10
7kg	11.3

B. Strain Analysis

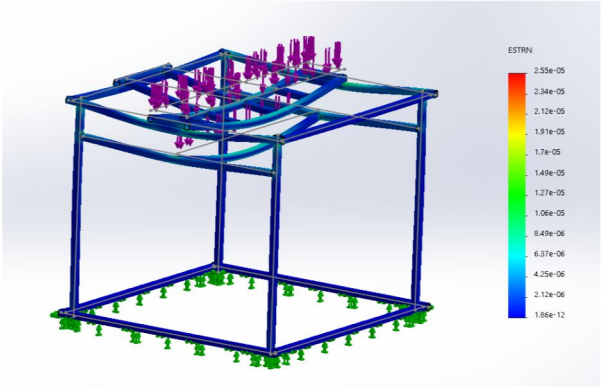

Fig. 9. 3kg Strain analysis

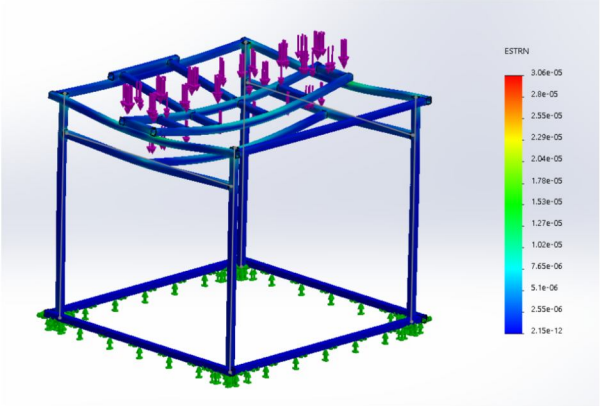

Fig. 10. 4kg Strain analysis

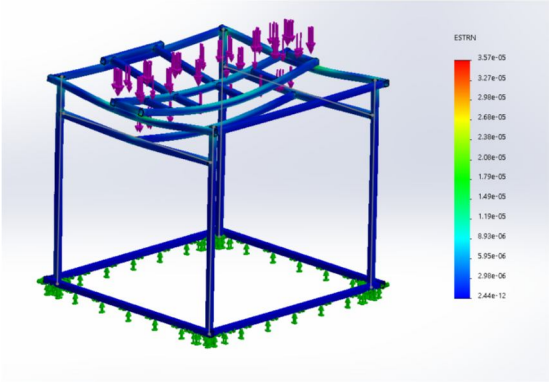

Fig. 11. 5kg Strain analysis

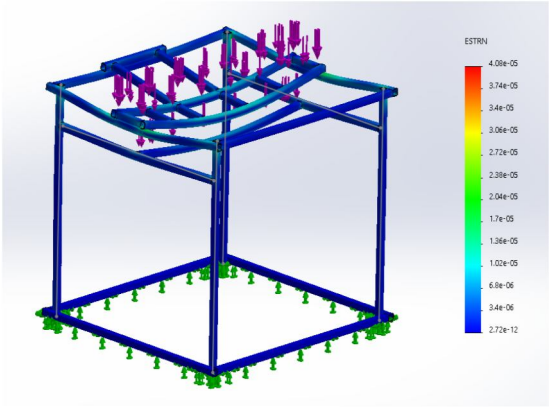

Fig. 12. 6kg Strain analysis

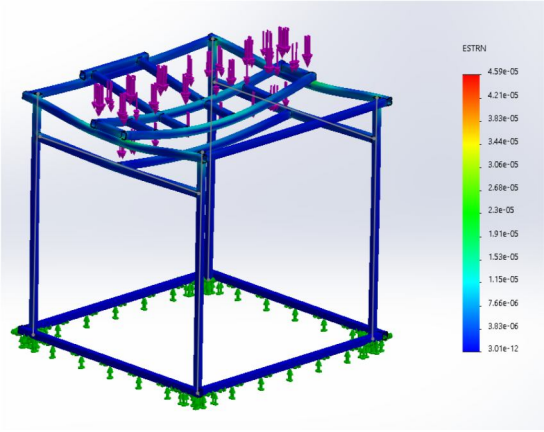

Fig. 13. 7Kg Strain analysis

Table 2. Strain Analysis

Load Applied(Kg)	Strain Induced
3kg	0.0000255
4kg	0.0000306
5Kg	0.0000357
6kg	0.0000408
7kg	0.0000459

C. Displacement Analysis

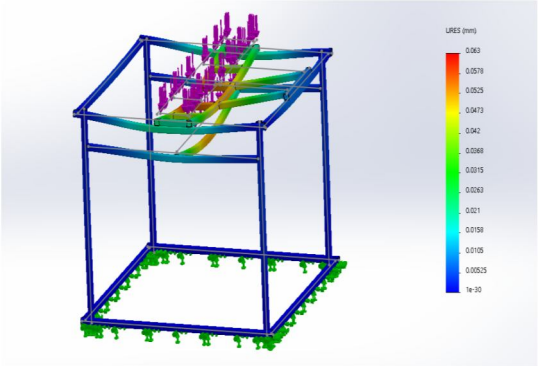

Fig. 14. 3kg Displacement analysis

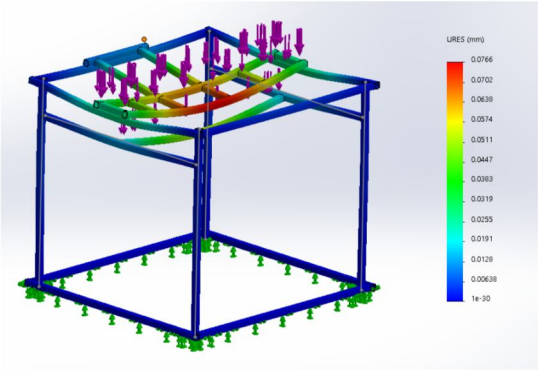

Fig. 15. 4Kg Displacement analysis

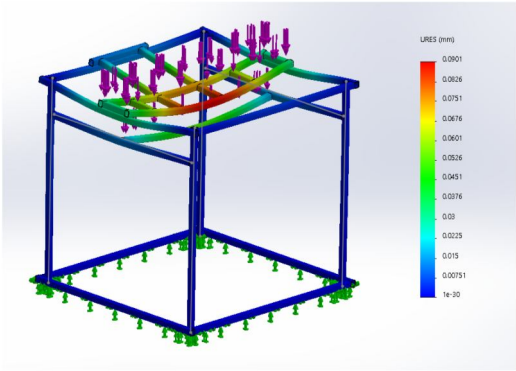

Fig. 16. 5Kg Displacement analysis

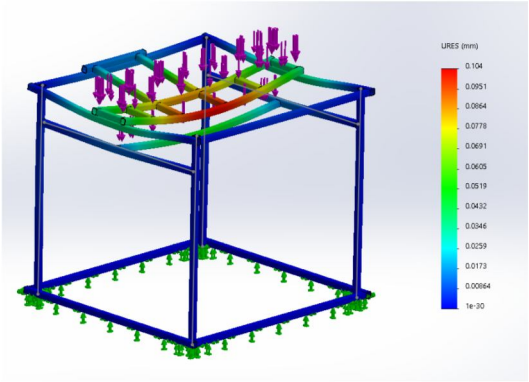

Fig. 17. 6Kg Displacement analysis

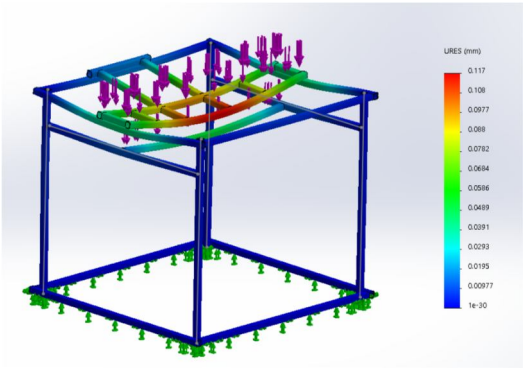

Fig. 18. 7kg displacement analysis

Table 3. Displacement Analysis

Load Applied (Kg)	Displacement (mm)
3kg	0.063
4kg	0.0766
5Kg	0.0911
6kg	0.104
7kg	0.117

D. Fabrication Model

The fabrication work is done by the mechanical process known as welding for joining different lengths of mild steel rod for obtaining the structure of frame and connecting the bevel gear with the rotating shaft and also to the motor for performing the operations. Three shafts of different lengths according to the need is taken and at one end of the each shaft is connected with grinding wheel, cutting wheel, and drill bit for performing the multiple operations.

Fig. 19.Fabrication model

X. RESULTS AND DISCUSSION

The following results can be drawn

A. The machine is useful particularly for small scale industries.
B. Workers movements can be minimized.
C. Number of operations can be carried out on the single machine.
D. Power consumption is reduced.
E. Floor area required is reduced.
F. Cost of manufacturing is also reduced.

XI. CONCLUSION

We see that all the industries, which are production based want low production cost and high work rate which is only possible through the utilization of multifunction operating machine which will use less power as well as less time and less labor. As this machine operates in different work centers this will be useful for the industry to reduce the time for manufacturing a product. In an industry some percentage of investment will be for setting up the machineries and so we have proposed a machine that Can perform three mechanical operations like drilling, cutting and grinding at different working centers simultaneously. This will be useful for the industrialist to reduce the investment in machineries.

XII. FUTURE SCOPE

A. We can perform boring operation by introducing a boring tool replacing drilling tool.
B. We can change the speed of motor by using the regulator.
C. Other operations can also be incorporated in to the machine.
D. The machine can be made more portable.
E. Cost can also be reduced to some extent by manufacturing it on a mass scale.

XIII. ACKNOWLEDGEMENTS

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A. Conflict of Interest

There is no conflict of interest to be described.

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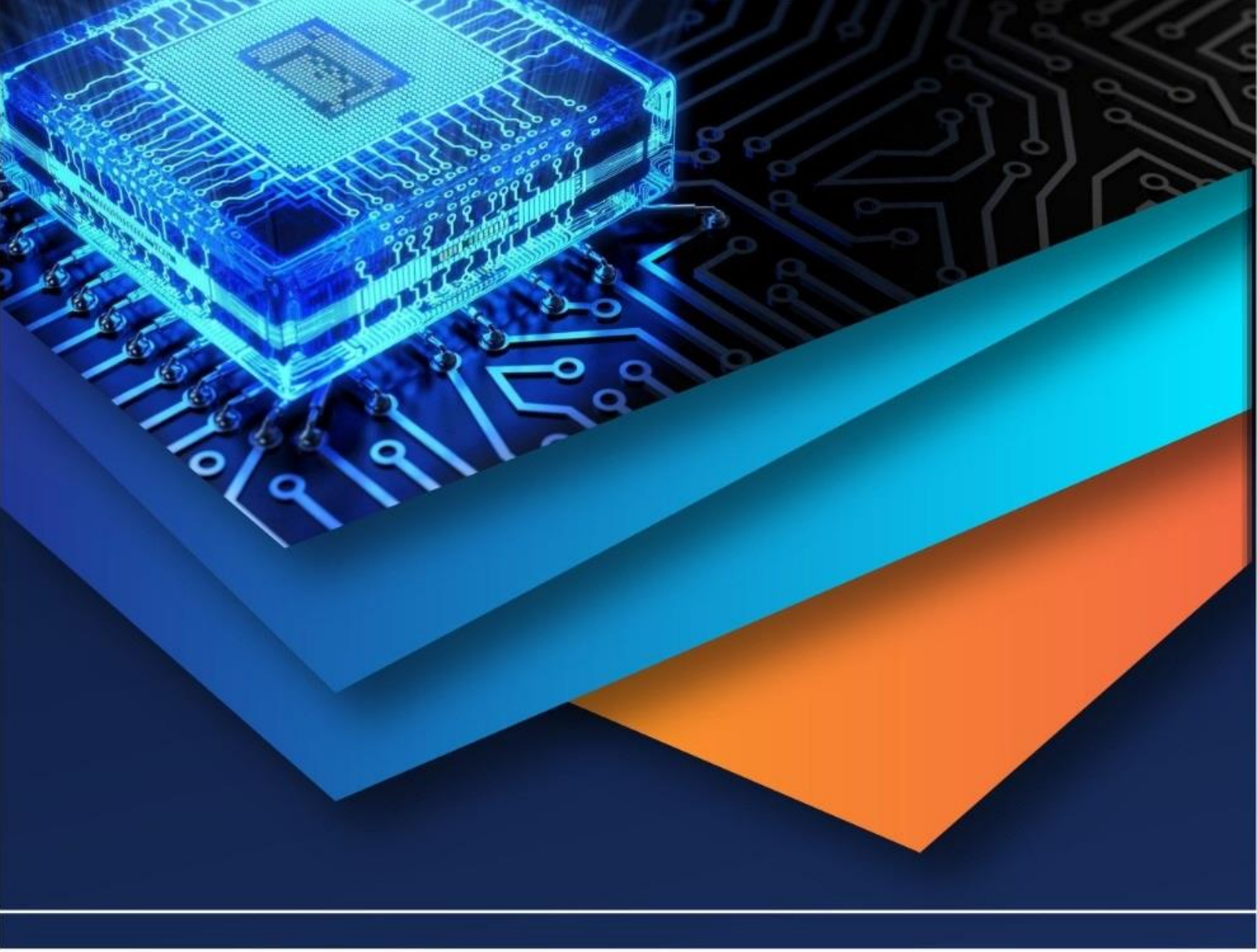

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