iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 **Issue:** II **Month of publication:** February 2025

DOI: https://doi.org/10.22214/ijraset.2025.66823

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue II Feb 2025- Available at www.ijraset.com

Fabrication of Five Speed Gear Box

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Abstract: This research delves into the refinement of a 5-speed gearbox mechanism through a comprehensive fabrication approach involving hole drilling. The study encompasses the entire fabrication process, from initial design considerations to performance evaluation, with a focus on enhancing efficiency and functionality. Through meticulous design optimization, material selection, and precision machining, the gearbox components are fabricated with strategically placed holes aimed at mitigating friction, improving lubrication distribution, and optimizing power transmission. Results demonstrate significant improvements in efficiency and performance metrics compared to conventional gearbox designs. Furthermore, the study highlights the broader implications of the fabricated gearbox, including its potential applications in automotive, industrial, and aerospace sectors, where efficient power transmission is critical for optimal performance and reliability. Overall, this research contributes to the advancement of gearbox technology by offering a novel fabrication technique and insights into improving mechanical system efficiency and functionality.

Keywords: Gearbox refinement, fabrication process, efficiency improvement, functionality improvement, design optimization, power transmission optimization, performance metrics, automotive applications, efficient power transmission, mechanical system efficiency

I. INTRODUCTION

Traditional five-speed gearboxes face a multitude of challenges that hinder their efficiency and performance on the road. Among these challenges, friction and heat generation within the gear trains stand out as significant contributors to energy loss and decreased mechanical output. As gears mesh and rotate, frictional forces build up, generating heat that dissipates energy and reduces overall efficiency. Over time, this constant friction can lead to premature wear and tear on gearbox components, compromising their durability and reliability. In addition to friction-related issues, the gear shifting mechanism often suffers from sluggishness and imprecision, impacting the responsiveness and driving dynamics of the vehicle. Delayed gear engagement and uncertain shifting patterns not only impede acceleration but also diminish the driver's confidence, especially during critical maneuvers such as overtaking or navigating through challenging terrain. Furthermore, the fixed gear ratios inherent in traditional gearbox designs may not fully accommodate the diverse performance needs of modern vehicles. This limitation can result in suboptimal speed or torque delivery across varying driving conditions, ultimately constraining the vehicle's adaptability and fuel efficiency.

Given these challenges, there is a pressing need to explore innovative solutions to enhance the performance of five-speed gearboxes. One such solution involves the strategic modification of gear trains through the implementation of drilled holes. By strategically drilling holes in specific locations within the gear train, several can be realized. Firstly, reducing the weight of gear components can help minimize inertia and rotational mass, leading to improved acceleration and responsiveness. Secondly, enhanced lubrication facilitated by drilled holes can reduce frictional losses and mitigate heat buildup, preserving energy and prolonging the lifespan of gearbox components. Additionally, optimizing gear engagement through drilled holes can promote smoother shifting transitions, enhancing the overall driving experience for motorists.

II. RESEARCH OBJECTIVE

Mohammed Anwar et al. [1] , they explore an innovative approach in the field of engineering and technology. The study focuses on Electro-Mechanical Power Transmission using a manual 5-speed gearbox for motor vehicles. As the demand for efficiency and environmentally friendly solutions increases, this research introduces a system that runs vehicles using an external source of power, reducing the reliance on traditional fuels. This electro-mechanical system incorporates a BLDC motor powered by batteries for electrical power and a five-speed gear box for mechanical power transmission, controlled by power and charge controllers. The vehicle's motion is driven by solar-generated electricity, which starts the BLDC motor. Power is transferred from the gear shafts to the rear wheel through a chain drive, and different speeds are achieved by manually shifting through the five-speed gear ratios. This innovative approach aims to reduce the dependency on fossil fuels and promote sustainable transportation methods, showcasing the potential of alternative technologies like solar arrays and battery-powered vehicles.

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Robert-Florin CERBU et al. [2] , they focus on the 3D design of an automotive 5-speed synchromesh gearbox using Autodesk Inventor. The gearbox is a crucial component that enables the conversion of speed and torque from the engine's rotary power supply (crankshaft) to the drive wheels while also facilitating the steering output. Autodesk Inventor is employed as a computer-aided design (CAD) tool for creating 3D digital prototypes, making it invaluable in mechanical design, visualization, tooling creation, and product simulation. It allows for the creation of prototype products that accurately simulate various properties like weight, stress, friction, and driving loads in a 3Denvironment. This paper provides a comprehensive guide, including graphical knowledge and operations, for generating a 3D model of a manual synchromesh gearbox using Autodesk Inventor. The process is explained step by step, starting from the initial mathematical calculation in Math connex. The study explores various aspects of transmission, CAD(Computer-Aided Design), gearbox design, Autodesk Inventor, front axle, and the concept behindthe3Dmodeling process.

Keiji Nemoto et al. [3] , they present the development of new in both 6-speedand5-speed configurations, have been designed to match the high revolutions and power output of the new i-VTEC engine, particularly for front-wheel-drive (FF) cars. The primary objectives of this development were to enhance fuel efficiency, achieve smoother transmission shifts, and create a compact design. To meet these goals, the transmission incorporates advanced technologies focused on reducing friction, weight, and transmission length. Additionally, it features a high-capacity synchronizer system capable of handling high rotational speeds, ultimately leading to improved. performance and efficiency in automotive application

M. Prabhu Ram et al. [4], the focus is on the development of a 4-speed automated manual transmission system for automobile applications. The growing demand for an effective and efficient automated manual transmission system with locally-sourced components has led to the creation of this system. The proposed model employs an Arduino microcontroller, electro-pneumatic solenoid valves, and pneumatic pistons. This automated gear shifting mechanism is designed as a self-gear-shifting system that adjusts the gear automatically as the vehicle's speed changes. A program has been created to enable continuous speed variation using Arduino IDE1.6. The developed system determines the appropriate gear for the given speed and actuates the corresponding gear by signalling an electrical relay.

These solenoid valves then trigger the relevant pneumatic piston, resulting in the desired gear change The research also explores the response time of the developed system, which uses compressed air in pneumatic cylinder sunder different pressure conditions. A finite element model has been created using ANSYS software to predict deformation and ensure the structural stability of the system. The results indicate that as the pressure increases, there is a significant reduction in response time for each gear shift. However, when the pressure exceeds 1.5 bar, the decrease in response time becomes negligible, eventually reaching a saturation point in response time. This study addresses the need for an indigenous automated manual transmission system in the automotive industry, showcasing innovative technologies and performance improvements.

S. Madhan Kumar et al. [5] , the primary focus is on the design, analysis, and fabrication of an automotive transmission gearbox with the goal of weight reduction. The motivation for this work is to enhance fuel economy by reducing the weight of the vehicle. Specifically, the research aims to reduce the weight of the automotive transmission gearbox without compromising its functionality. The transmission gearbox is crucial in transmitting power and torque from the engine to the drive axle, with different velocity ratios based on the engaged gears and the number of teeth in those gears. The project tackles weight reduction by conserving material and improving transmission efficiency. This is achieved through stress analysis and the fabrication of the gearbox by drilling holes into the gears while they are in a red-hot condition. Various types of holes, differing in size and shape, are incorporated into the gears. Both software and prototype analysis are conducted. The results indicate that circular holes with a diameter of 2.25 mm in the gears lead to a 7% increase in power and torque transmission, along with substantial savings in material and improvements in fuel economy. This research showcases an innovative approach to reducing the weight of an automotive transmission gearbox through material-saving techniques, ultimately contributing to improved vehicle efficiency and fuel economy.

III.OBJECTIVE

The objective of this project is to create a novel five-speed gearbox design that achieves both lightweight construction and high performance. This will be accomplished through a unique fabrication technique that involves drilling strategically positioned holes within the gear trains.

The project aims to achieve a measurable reduction in gearbox weight through this method, leading to improved overall performance. Additionally, the hole drilling strategy is designed to enhance the efficiency and torque output of the gearbox. By comparing this design to conventional gearboxes, the project will quantify the effectiveness of the approach in achieving both weight reduction and performance improvements.

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IV. COMPONENTS DESCRIPTION

A. Gear Trains

There are total five different gear teeth on 3 of each gear shaft making total of 15 gear trains.

Each gear in the gear train plays a crucial role in transmitting torque and adjusting the speed to achieve the desired output. The combination of gears with different numbers of teeth allows for precise control over the gear ratio, enabling the gear train to meet specific performance requirements for various applications.

Fig.1. Gear Trains

B. The Shaft or Screw Rod

The screw rod serves as a critical component for mounting gear trains within machinery or equipment. Typically constructed from high-strength steel or alloy materials, its robust build ensures durability and resistance to wear, crucial for enduring the demands of various industrial applications. Precision machining results in a smooth surface finish, essential for minimizing friction and enabling seamless rotation of the gears along the shaft. Keyways or splines may be integrated into the shaft's design to securely connect the gears, preventing slippage and maintaining proper alignment during operation.

Fig.2. Shaft or Screw rod

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C. Bearings

Bearings play a pivotal role in ensuring the smooth rotation and efficient operation of a screw rod within a gear train. Typically, cylindrical roller bearings or ball bearings are employed for this purpose, chosen for their ability to withstand radial and axial loads while minimizing friction. These bearings are meticulously engineered with precision-machined races and rolling elements, providing a low-friction interface between the screw rod and the surrounding housing. The inner race of the bearing snugly fits onto the screw rod, while the outer race is securely mounted within the gearbox housing or support structure. This arrangement allows the screw rod to rotate freely while maintaining alignment and stability, even under heavy loads or high speeds.

Fig.3. Bearings

D. 60 Rpm Motor

The 60 RPM motor serves as the prime mover responsible for rotating the gears within the gear train at a consistent speed of 60 revolutions per minute. This motor is meticulously engineered to provide the necessary power and torque required to drive the gear train efficiently while maintaining a steady rotational speed. Its design incorporates high-quality components, such as a robust rotor and stator assembly, precision bearings, and efficient cooling mechanisms, to ensure reliable performance and longevity.

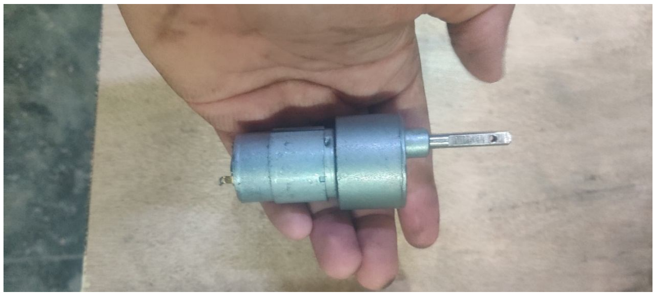


Fig.4. Beraings

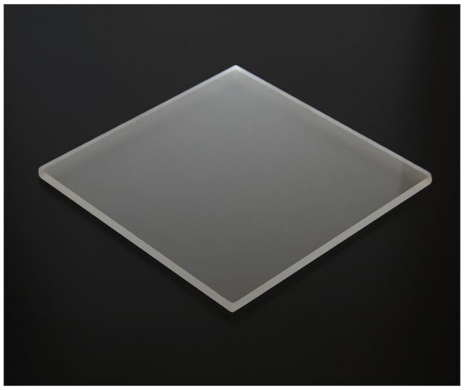
E. Wheel

The small plastic wheel, measuring 4 inches in diameter, is a versatile and lightweight component used in various applications across industries. Crafted from durable yet lightweight plastic materials such as polyurethane or nylon, this wheel offers exceptional strength and resilience while remaining cost-effective. Its compact size makes it ideal for use in smaller machinery, equipment, or DIY projects where space is limited. Despite its diminutive stature, the 4-inch plastic wheel boasts impressive load-bearing capabilities, able to support moderate loads with ease.

Fig.5. Wheels

F. Acrylic Sheet

The acrylic sheet used for covering the gear box is a transparent or translucent thermoplastic material renowned for its exceptional clarity, durability, and versatility. Manufactured from polymethyl methacrylate (PMMA), this sheet offers superb optical properties, allowing for clear visibility of the enclosed gear components while providing protection against dust, debris, and environmental elements. Its high impact resistance and weatherability make it suitable for outdoor applications, ensuring long-term performance even in harsh conditions.



G. Body

The wooden body for supporting a gearbox serves as a sturdy and reliable base to securely mount and protect the gearbox within a larger mechanical system or structure. Typically crafted from high-quality hardwoods such as oak, maple, or beech, the wooden body offers excellent strength, stability, and shock absorption properties. Its solid construction provides a robust platform to withstand the forces and vibrations generated during gear operation, ensuring the gearbox remains securely in place and properly aligned.

Fig.7. Body

H. Power Supply

Voltage Output: The power supply is designed to deliver a stable output voltage of 12 volts DC (direct current). This voltage level is commonly used in automotive, industrial, and electronic applications where low-voltage power is required to operate various components, including gearboxes.

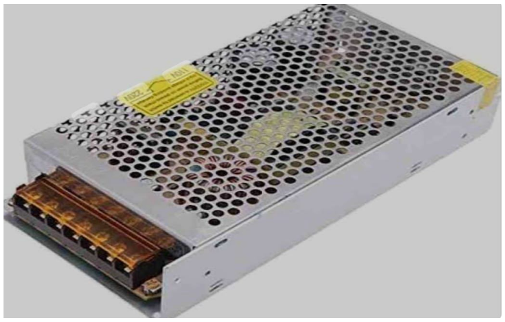


Fig.8. Power Supply

Table.1. Maiin components

	During 1st Gear	During 2nd Gear	During 3rdGear	During 4thGear	During 5thGear
Gear Trains on 1st Shaft	26GT	22GT	20 GT	20 GT	20 GT
Gear Trains on 2ndShaft	20 GT	18 GT	20 GT	18 GT	16 GT
Gear Trains on 3rdShaft	20 GT	20 GT	20 GT	22 GT	26 GT

V. BLOCK DIAGRAM

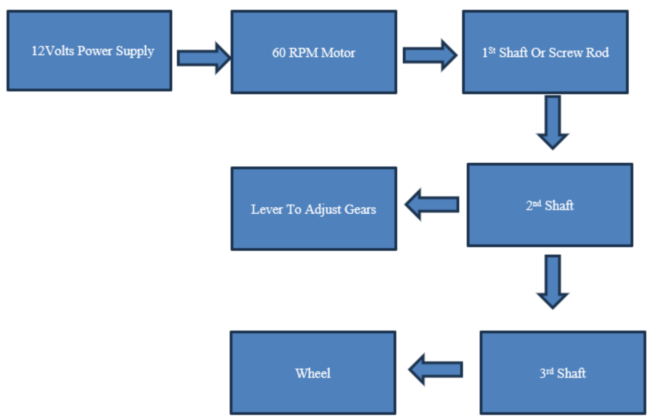


Table 2. Gear Aliognment during working

Gear Trains	(26 Teeth-2) (22Teeth-2) (20Teeth-7) (18Teeth-2) (16 Teeth-2)_ **Total Number Of Gear Trains = 15**
Shaft Or Screw Rod	3
DC MOTOR	60RPM
Wheel	Plastic;4inch
Power Supply	12 Volts
FRAME	W-10; L-12; H-12

VI. WORKING

In the operation of the 5-speed gearbox attached to a 60 RPM motor powered by a 12-volt power supply, the process begins with the motor receiving electrical power from the power supply, causing it to rotate at a constant speed of 60 revolutions per minute (RPM). This rotational motion is transmitted to the first gear train connected directly to the motor shaft, which consists of five gears mounted on the first screw rod. Each gear train within the gearbox has holes drilled on them to enhance performance, facilitating smoother operation, improved cooling, and reduced friction.

As the motor rotates, the first gear train meshes with the second gear train, transferring rotational motion and torque to the second screw rod. This second gear train, also comprised of five gears with drilled holes, continues to amplify or reduce the speed and torque as dictated by the gear ratios. The process repeats as the second gear train meshes with the third gear train, mounted on the third screw rod. Again, the drilled holes on the gears contribute to the overall efficiency and performance of the gearbox.

Finally, the rotational motion from the third screw rod is transmitted to the wheel attached to it. The wheel rotates at a speed determined by the cumulative gear ratios of all the gear trains within the gearbox. The drilled holes on the gear trains ensure optimal cooling, reduced vibration, and enhanced durability, contributing to the smooth and reliable operation of the gearbox. Additionally, the 12-volt power supply ensures a consistent power source for the motor, maintaining stable performance throughout operation.

Overall, the interconnected gear trains, powered by the 60 RPM motor and supported by the 12-volt power supply, work in tandem to transmit rotational motion and torque efficiently, with the drilled holes on the gear trains playing a crucial role in enhancing performance and durability. The wheel attached to the third screw rod serves as the output, translating the rotational motion of the motor into useful mechanical work, making the entire system suitable for various industrial applications where precise control over speed and torque is required.

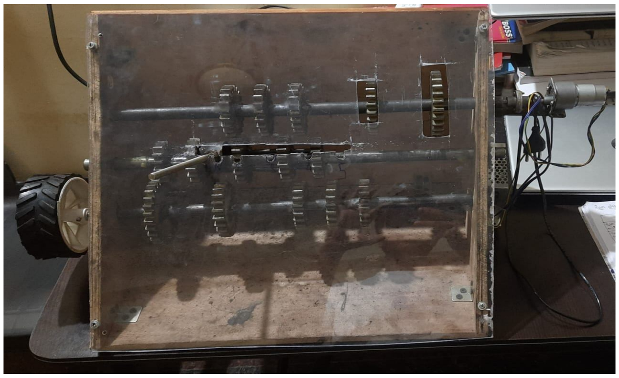
As the motor continues to rotate at a consistent speed of 60 RPM, the gear trains within the gearbox act to further refine and optimize the transmission of power. Each gear train serves a specific purpose in adjusting the speed and torque to meet the requirements of the application.

The first screw rod, receiving the rotational motion from the motor through the initial gear train, sets the foundation for the subsequent gear trains' operation. The drilled holes on the gears aid in maintaining optimal temperature levels by facilitating airflow and heat dissipation, ensuring that the gearbox operates within its designated temperature range for prolonged reliability.

As the rotational motion is transferred from one gear train to the next, the cumulative effect of the gear ratios results in a finely tuned output speed and torque at the final screw rod. This output is crucial for driving the attached wheel or performing specific mechanical tasks, providing the desired functionality for the application at hand.

Moreover, the 12-volt power supply ensures a stable and consistent electrical power source, supporting the motor's operation throughout its duty cycle. This reliability is essential for maintaining continuous operation and preventing fluctuations in motor speed or torque, thereby ensuring consistent performance of the gearbox.

Furthermore, the drilled holes on the gear trains not only enhance performance but also contribute to the overall longevity and durability of the gearbox. By reducing friction and wear on gear teeth, these drilled holes help extend the service life of the gearbox, reducing maintenance requirements and downtime.



VII. FUTURE SCOPE

The future scope of a 5-speed gearbox with drilled holes on the gear trains to enhance performance is vast and promising, with numerous avenues for innovation and advancement. Here's an exploration of some potential future directions:

1) Advanced Materials: Future iterations of gearboxes may incorporate advanced materials such as carbon fiber composites or ceramics, which offer superior strength-to-weight ratios and enhanced thermal properties. These materials could further reduce weight, improve efficiency, and increase durability, contributing to overall performance gains.
2) Smart Gearbox Technology: Integration of sensors and monitoring systems within the gearbox could enable real-time monitoring of temperature, vibration, and wear. Advanced algorithms and machine learning techniques could analyze this data to optimize gear shifting strategies, predict maintenance needs, and prevent potential failures, enhancing reliability and reducing downtime.

3) Modular Design: Future gearboxes may adopt a modular design approach, allowing for easy customization and scalability to meet diverse application requirements. Modular components, including gear trains with drilled holes, could be easily swapped or upgraded, providing flexibility and adaptability in various industries and applications.
4) Enhanced Cooling Solutions: Innovations in cooling technology, such as integrated liquid cooling systems or passive heat dissipation methods, could further optimize thermal management within the gearbox. By efficiently removing heat generated during operation, these cooling solutions could improve reliability, extend component lifespan, and enable higher power densities.
5) Integrated Electric Propulsion Systems: In the automotive sector, advancements in electric propulsion systems could lead to the development of high-performance electric vehicles with sophisticated multi-speed gearboxes. These gearboxes, equipped with drilled holes for enhanced performance, could play a crucial role in maximizing efficiency and range while maintaining optimal driving dynamics.

VIII. ADVANTAGES

1) Improved Cooling: Drilled holes on gear trains enhance heat dissipation, reducing operating temperatures and prolonging the lifespan of gearbox components.
2) Reduced Friction: The drilled holes reduce surface contact area between gears, minimizing frictional losses and increasing overall efficiency.
3) Enhanced Durability: By reducing wear on gear teeth and other components, drilled holes contribute to improved durability and longevity of the gearbox.
4) Optimized Performance: The combination of reduced friction and improved cooling leads to optimized gearbox performance, resulting in smoother operation and better power transmission.
5) Increased Efficiency: Drilled holes help to minimize energy losses within the gearbox, leading to improved energy efficiency and reduced power consumption.
6) Customization Options: Gearboxes with drilled holes offer customization options such as adjustable hole patterns and sizes, allowing for tailored solutions to meet specific application requirements.
7) Lightweight Design: The use of drilled holes can help to reduce the overall weight of the gearbox, resulting in lighter and more compact designs that are easier to install and integrate into various systems.
8) Noise Reduction: Drilled holes can help to dampen noise and vibrations generated during gear operation, resulting in quieter and smoother gearbox operation.
9) Environmental Benefits: Reduced energy consumption and improved efficiency contribute to lower carbon emissions and environmental impact, aligning with sustainability goals.
10) Versatility: Gearboxes with drilled holes are versatile and adaptable, suitable for a wide range of applications across various industries, including automotive, aerospace, industrial machinery, and renewable energy systems.

IX. CONCLUSION

In conclusion, the fabrication of a 5-speed gearbox with drilled holes on gear trains represents a significant advancement in gearbox technology, offering a range of benefits and opportunities for innovation. By incorporating drilled holes into gear trains, engineers can achieve improved performance, efficiency, and durability, making these gearboxes highly desirable for a wide range of applications across various industries. The drilled holes contribute to enhanced cooling, reduced friction, and optimized power transmission, leading to smoother operation, increased reliability, and longer service life. However, it's essential to carefully consider potential disadvantages such as increased manufacturing complexity, maintenance challenges, and compatibility issues. Despite these considerations, the advantages of gearboxes with drilled holes outweigh the drawbacks in many cases, making them a compelling choice for demanding applications where precision, efficiency, and reliability are paramount. Moving forward, continued research, development, and refinement of this technology will drive further innovation and advancement, paving the way for even more efficient and versatile gearbox solutions in the future.

In the ever-evolving landscape of engineering and technology, the fabrication of 5-speed gearboxes with drilled holes on gear trains represents not just a single advancement, but a steppingstone towards a future of unparalleled performance and efficiency. As industries continue to push the boundaries of what is possible, these gearboxes stand at the forefront, embodying the ingenuity and dedication of engineers striving for excellence.

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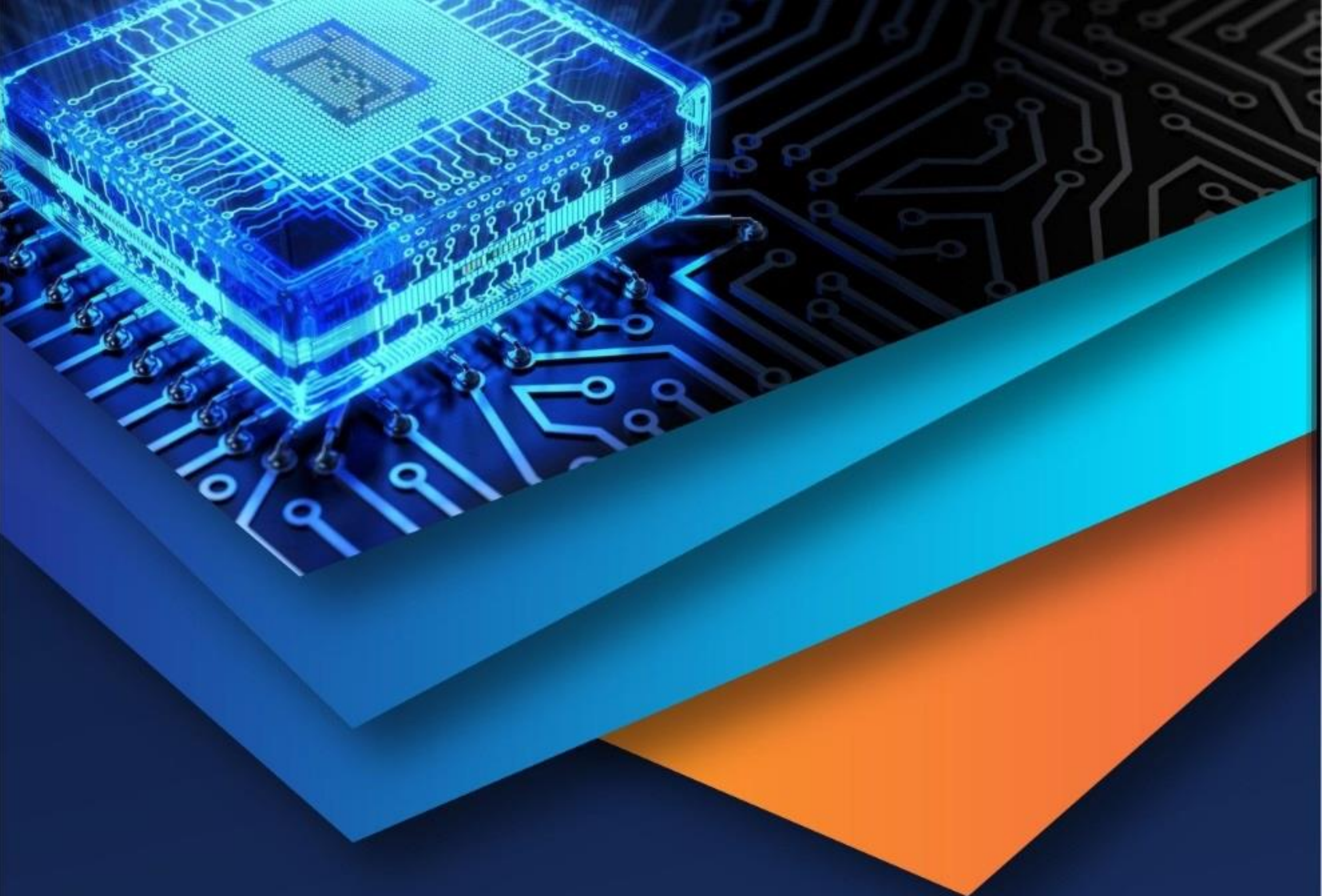

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