iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** V **Month of publication:** May 2022

DOI: https://doi.org/10.22214/ijraset.2022.43146

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue V May 2022- Available at www.ijraset.com

Experimental Evaluation of Nanofluid for Improved Cooling Efficiency in an AL Mini Channel Heat Sink

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Abstract: ***Efficient heat transfer has become major need these days. In this thesis, both experimental and CFD investigations have to be carried out to evaluate the cooling performance of a mini-channel consisting of fins on upper surface of flat plate. Nano fluids contain a small fraction of solid nano particles in base fluids flowing through groves in bottom plate attached with heater at base. Nano fluids cools small channel heat sinks, have been anticipated to be an excellent heat dissipation method for the next generation electronic devices. Computational Fluid Dynamics (CFD) simulations is to be carried out to study the heat sinks heat transfer mechanism. The sectional geometry of channels affects the flow and heat transfer characteristics of mini channel heat sinks. The heat transfer principle states that maximum heat transfer is achieved in mini channels with minimum pressure drop across it. In this research work the experimental and numerical investigation for the improved heat transfer characteristics of mini channel heat sink using Al_2O_3/water nano with (1 and 2 % volume fraction) fluid is to be done. The fluid flow characteristics are also analysed for the serpentine shaped mini channel. Heating element of 130 W capacities is to be used to heat up the heating element of base plate.***

Keywords: Heat, Fluids, Heating, Nano, Fraction, Flow, Sink, Channel, Plate, Aluminum.

I. INTRODUCTION

With the advances in computing technology over the past few decades, electronics have become faster, smaller and more powerful. This results in an ever-increasing heat generation rate from electronic devices. In most cases, the chips are cooled using forced air flow. However, when dealing with a component that contains billions of transistors working at high frequency, the temperature can reach a critical level where standard cooling methods are not sufficient.

The application of micro channels in heat transfer was first proposed by Tuckerman in the electronic chip which could be effectively cooled by means of water flow in micro channels fabricated on the circuit board on which the chips are mounted. The need for thermal management in high end power electronic workstations cooling, application servers and data centres are an exceedingly demanding area that requires continuous research efforts to develop efficient and cost competitive cooling solutions.

II. AIM & OBJECTIVES

To understand the cooling performance for water and nano fluid in designed square plate design with groves on base plate and with rectangular pin fin arrangement on upper plate.
To understand the effect of nano particle (Al_2O_3) with two different volume concentration 1% & 2% at different flow rates
To determine the temperature, pressure plot distribution across heat sink apparatus.
Experimental investigation is to be carried out for heat sink using different cooling mediums namely water and nano fluid.
Comparison of experimental and CFD simulation results.

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III.METHODOLOGY

We started the work of this project with literature survey. gathered many research papers which are relevant to this topic. After going through these papers, we learnt circular shaped mini channel heat sink

↓

After that the selection of Heat Sink which is required for our project are decided.

↓

After deciding the components, the 3D Model and drafting will be done with the help of CATIA software.

↓

Computational Fluid Dynamics (CFD) simulations of circular Shaped Mini channel Heat Sink will be done with the help of ANSYS Fluent software.

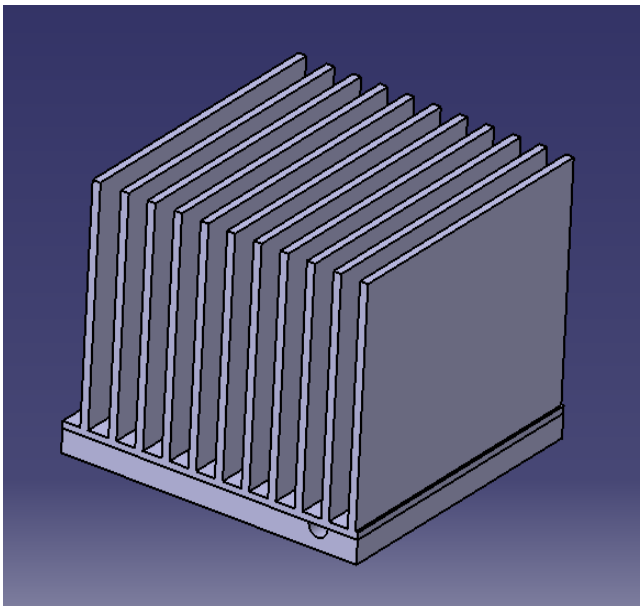
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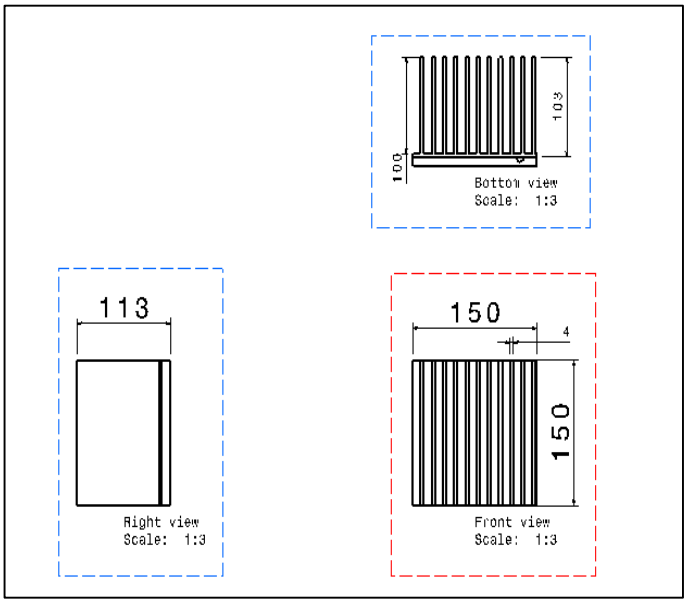
The actual manufacturing of circular Shaped Mini channel Heat Sink will be done and after that Experimental reading are noted down

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Comparative analysis between the experimental & CFD result & then the result & conclusion will be drawn.

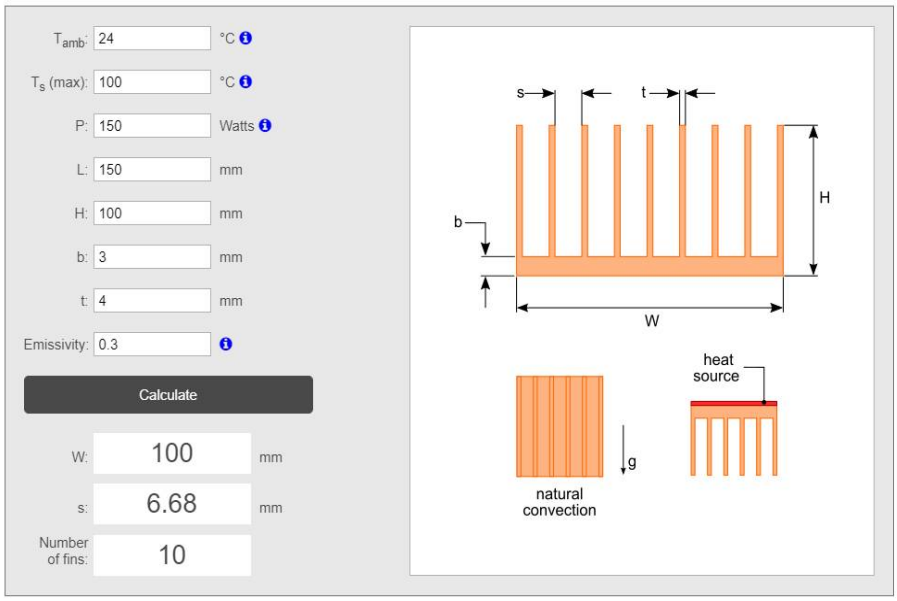
A. Catia and Drafting of Heat Sink



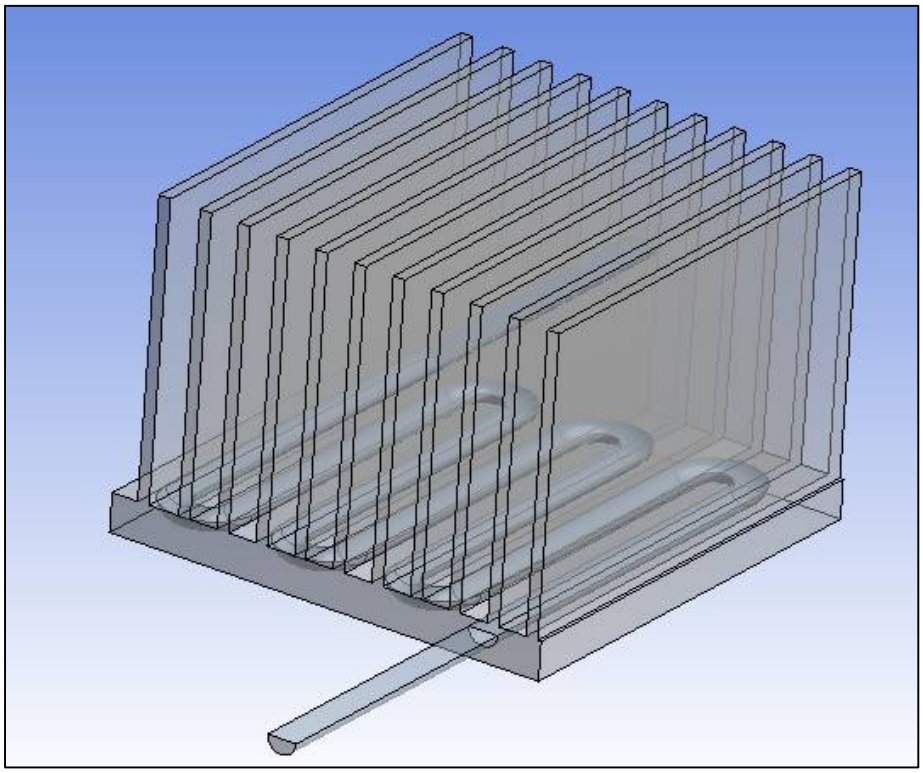


B. Heat Sink Calculation

In present research heat sink with base plate having groves are performed and top plate contain pin fin rectangular arrangement.
In pin fin to calculate the number of fins required for efficient heat dissipation on top plate it is calculated by heat sink calculator in which required parameter are filled namely length, with, heating temperature to calculate number of fins.
So, approximately for convenience 11 fin are selected.

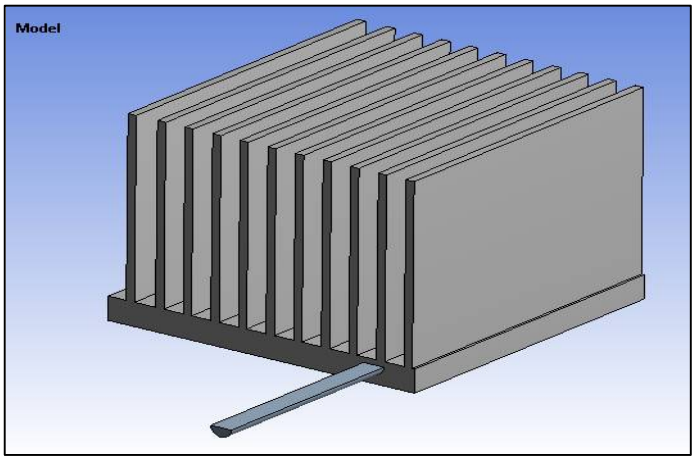


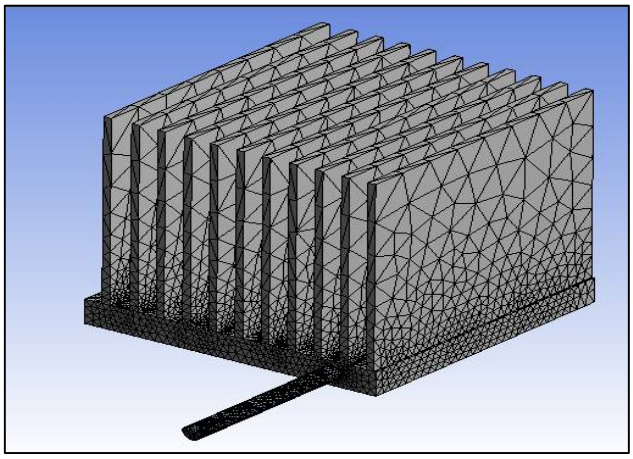
C. Heat Sink with Groove for Nanofluid as Coolant



First water as coolant is to be studied later nano fluid with different volume fraction is to be considered.

D. Details of Meshing

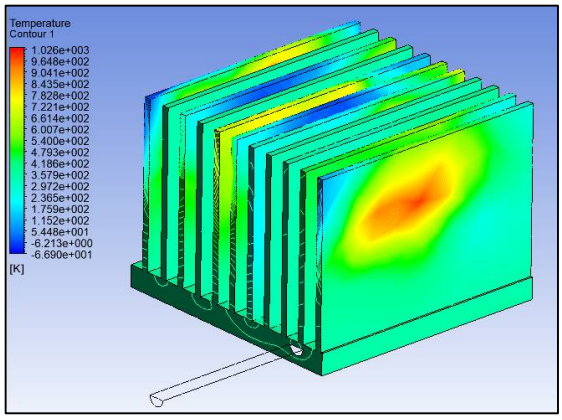




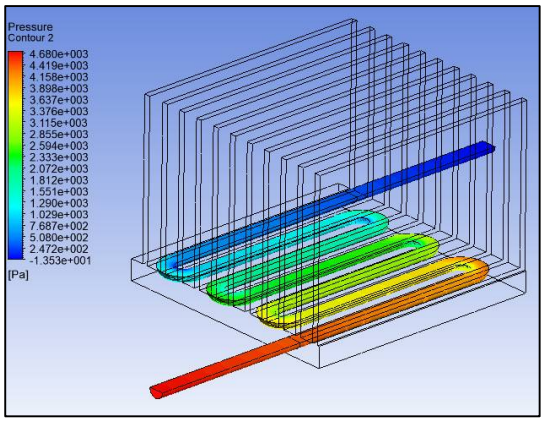
In Present Study Fluid as Water is Considered to Understand the Effect of Heater Placed at bottom Surface. Later Nano fluids are introduced to enhance Heat Transfer Parameters.

Statistics	
Nodes	77619
Elements	353899

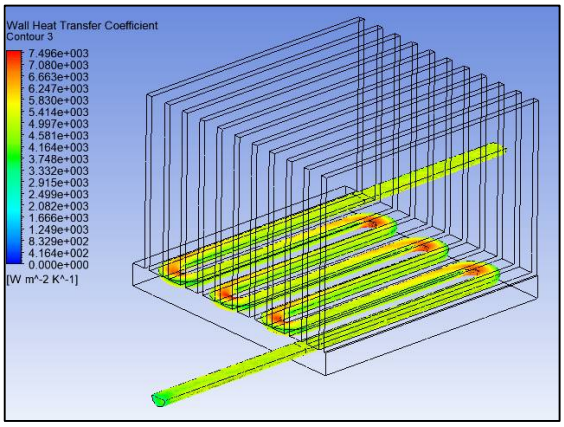
Contours for Water



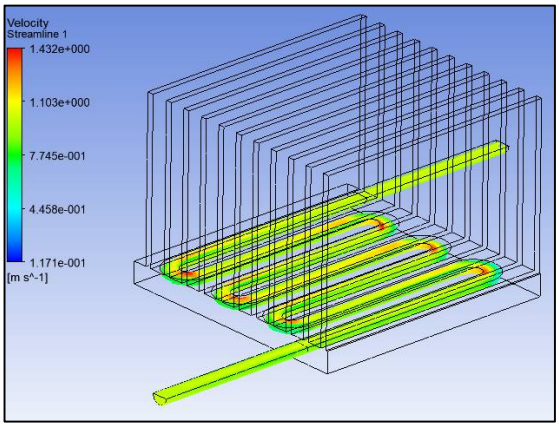
5.1 Temperature Contour



5.2 Pressure Contour

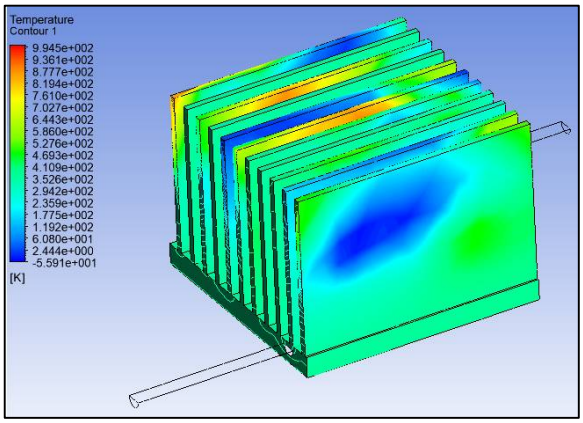


5.3 Heat Transfer Coefficient

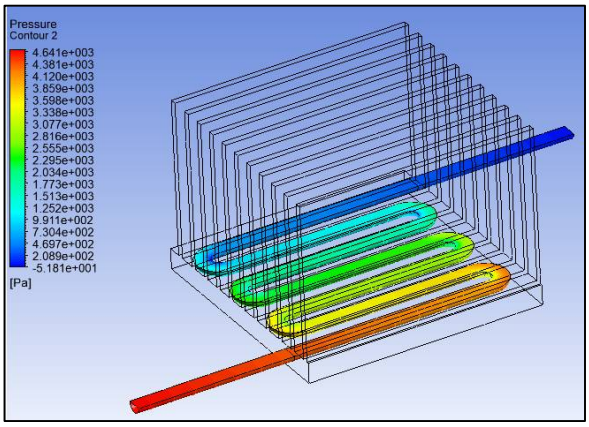


5.4 Velocity along Stream line Plot Contour

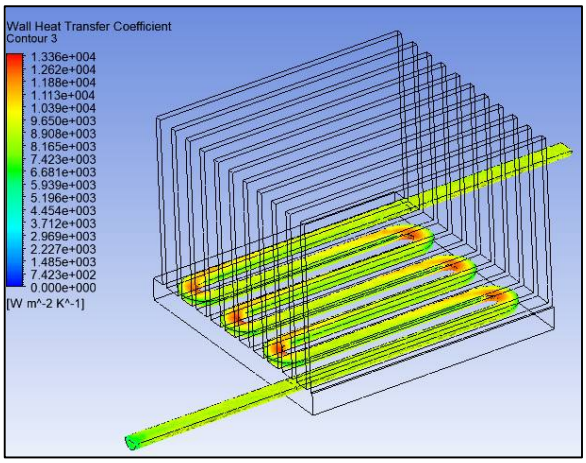
E. Contours for Nanofluid at 1% Volume Fraction Effect



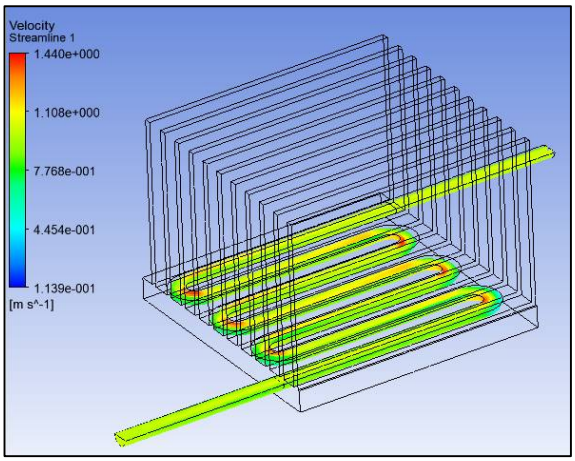
6.1 Temperature Contour



6.2 Pressure Contour

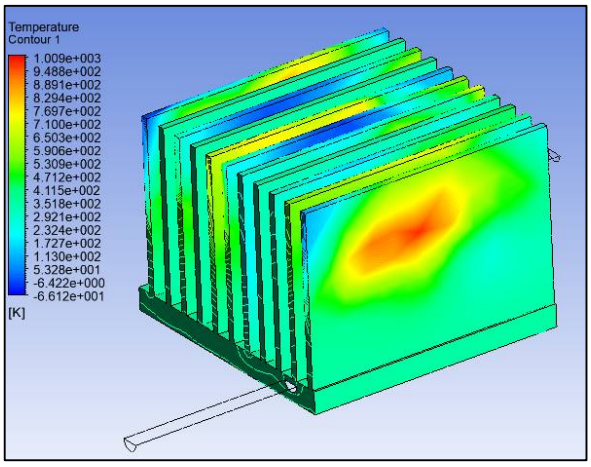


6.3 Heat Transfer Coefficient

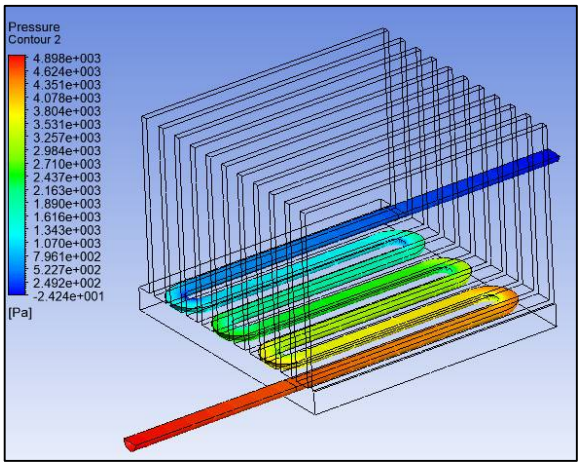


6.4 Velocity along Stream line Plot Contour

F. Contours for Nanofluid at 2% Volume Fraction Effect



7.1 Temperature Contour



7.2 Pressure Contour

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IV. LITERATURE REVIEW

Valentin Apostol et al. [1], this research paper presents study of the effect of Nano fluids on the micro channel heat sink performance of computer cooling systems. In this experiment CeO2, Al2O3 and ZrO2 nanoparticles suspended in 20% ethylene glycol and 80% distilled water are used as working fluids. The concentration of the nanoparticles ranges from 0.5% to 2%, mass flow rate ranges from 0.028 kg/s to 0.084 kg/s, and the ambient temperature ranges from 25 C to 40 C. Author experimental investigate the thermal component, parameters such as thermo-physical properties of the Nano fluids and base fluids, central processing unit (CPU) temperature, heat transfer coefficient, pressure drop, and pumping power.

Tu-Chieh Hung et al. [2], in this paper numerical study is done for improve the heat transfer in a 3-D micro channel heat sink (MCHS) by using Nano fluids. Thermo-physical properties of coolant fluid are changes by addition of nanoparticles in it. These Thermo-physical properties are closely related to the type of nanoparticle, base fluid, particle volume fraction, particle size, and pumping power.

Hao Li et al. [3], Researchers discuss about the topology optimization. They study the relationship between the thermal hydraulic performances and the layout of cooling channels designed by topology optimization from the engineering perspective. Here they discuss about two type of topology optimization.

V. RESULT

Table. Comparison of experimental testing results

MEDIUM	INITIAL TEMPERATURE (FIN)	FINAL TEMPERATURE (FIN)	BASE TEMPERATURE (HEATER)	LIQUID INITIAL TEMPERATURE	LIQUID INITIAL TEMPERATURE
Water	34	30	60	27	30
	50	45	70	27	34
Nano fluid	34	27	60	29	35
	50	41	70	29	41

VI. CONCLUSION

1) In present experiment water has been used in existing condition to study its physical properties to enhance heat transfer parameters.
2) Heat sink has been designed to study cooling performance of component with heating element placed below bottom plate.
3) In present stage water as coolant medium is studied to determine pressure, temperature and heat transfer coefficient contour plot.
4) It is observed that using alumina as nanofluid with 1 and 2 % volume fraction temperature as well as pressure drop have been reduced along with increase in heat dissipation heat transfer coefficient is observed.
5) Experimental testing has been concluded that water containing nanofluid have been more effective with more heat absorbing characteristics and less heated surface of fin of heat sink with specified temperature applied by heater.

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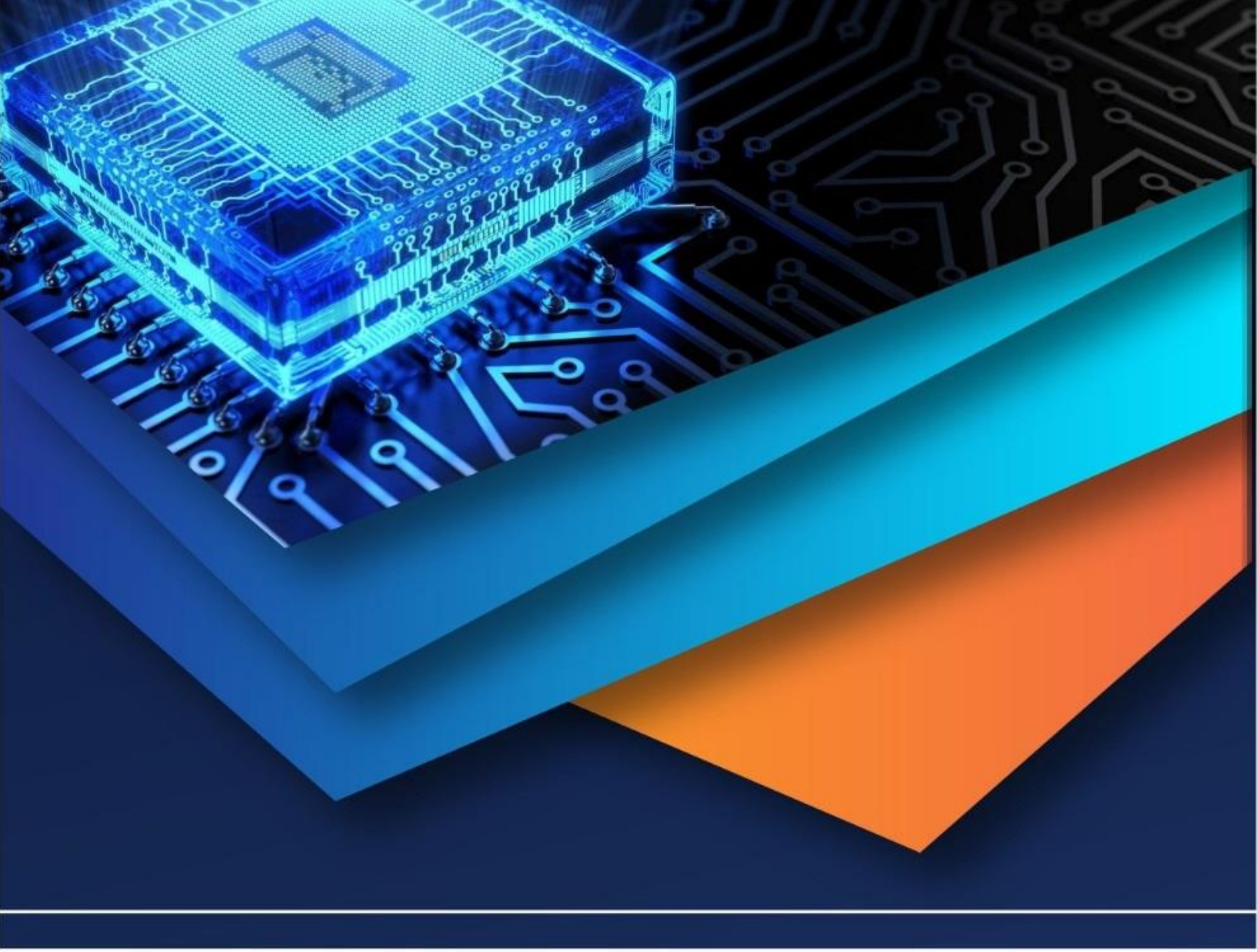
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