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Regression Analysis Performed with Respect to the Velocity and Temperature

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Abstract: ***Today vehicles are like our necessity in life. Most of the people of metro cities spend minimum 2-4 hour daily in their car. So people want better thermal comfort. Nowadays companies start focusing on customer choice. Vehicular cabin climate is adjusted by making changes in dry bulb temperature. It depends upon person that in which range person feels thermally comfort. This temperature range is always deviate from person to person. Every person has different metabolic rate so range of thermal comfort diverges person to person and it also depend upon clothing of people. If more powerful air-conditioner is applied then it affects the car performance means it lessen the average of vehicle. Air-conditioner will be applied in a limit. Thermal comfort is depending upon capacity of air conditioner, air velocity in car cabin, Air temperature, humidity and air flow distribution. So, first thing is capacity of air conditioner that will not be altered to higher value because AC is one and the only thing which consumes more power than other equipment. If large air conditioner is applied it will not be economical also. This is not the optimal solution for increasing thermal comfort. Air temperature can be decreased to improve thermal comfort but in this case size or capacity of air-conditioner will increase, ultimately this will increase cost. Last parameter is air flow distribution in which the pattern of air flow will be analyzed. In hatchback cars always there is a complaint of uneven cooling means cooling at front seat is good but very less cooling at back seat. Generally after an hour you feel some cooling at back. So there is need of optimal solution which is not too costly and also economic with respect to kilometer per liter. In this study of air pattern conclusion can be drawn that if there is any A.C. 2 vent will also present for back seat. Thermal comfort is also relying on Glass transmissivity of window glass in car cabin.***

Keywords: Taguchi method, Anova analysis , Regression Analysis

I. INTRODUCTION

Thermal comfort of any car is due to the influence of car cabin design, location of vents in car, number of vents in cabin, relative humidity and inlet position of air. In this work, a Swift car‘s cabin has considered because this is the most popular car. Generally, number of experiment has done to know the consequences. But to form number of experiment is a bit difficult for researcher. So, a scientific approach was used and that is done by the help of Taguchi method. DOE is a very efficient process because it help researcher in getting results in a few cases. DOE always aim that researcher get all important data or information in minimum number of cases. DOE does sampling of various factors and levels. After attainment of selected cases, simulation is started. Some knowledge from literature is very beneficial for study like parameters which generally involve in changing the thermal comfort either better or poor. In our work, we have taken radiation effect for simulation, and five parameters are air velocity, air temperature, vane angle, glass transmissivity, inlet position. Some knowledge from literature is very beneficial for study like parameters which generally involve in changing the thermal comfort either better or poor. In our work, we have taken radiation effect for simulation, and five parameters are air velocity, air temperature, vane angle, glass transmissivity, inlet position.DOE have an advantage of changing more than one factor quickly and get significant values from them and can judge which factor is more influencing. Taguchi model helps in determining that all the factors are not taking part actively to change the observations.

Thermal comfort‖ is defined by the American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE) as ―the state of mind that expresses satisfaction with the surrounding environment‖.[17] No of indices are available for the formulation of comfort. But one of the common indices is PMV model. Predicted mean value is expectable to +0.5 to -0.5. Vehicular climate is very transient in nature so it is really a complex task to find thermal comfort because there are mainly six factors which is as follows:

1) Air temperature
2) Air humidity
3) Mean radiant temperature

4) Human activity
5) Air velocity
6) Clothing insulation
7) Thermal comfort of any car is due to the influence of car cabin design, location of vents in car, number of vents in cabin, relative humidity and inlet position of air. In this work, a Swift car's cabin has considered because this is the most popular car. Generally, number of experiment has done to know the consequences. But to form number of experiment is a bit difficult for researcher. So, a scientific approach was used and that is done by the help of Taguchi method.
8) DOE is a very efficient process because it help researcher in getting results in a few cases. DOE always aim that researcher get all important data or information in minimum number of cases. DOE does sampling of various factors and levels. After attainment of selected cases, simulation is started.
9) Some knowledge from literature is very beneficial for study like parameters which generally involve in changing the thermal comfort either better or poor. In our work, we have taken radiation effect for simulation, and five parameters are air velocity, air temperature, vane angle, glass transmissivity, inlet position.
10) Here, thermal comfort depicts that average air temperature of car cabin. This can be done by changing air temperature, location of vents, and many other which was considered in this thesis.
11) DOE have an advantage of changing more than one factor quickly and get significant values from them and can judge which factor is more influencing. Taguchi model helps in determining that all the factors are not taking part actively to change the observations.

II. MATERIALS AND METHODS

A quality review has been performed in this thesis so that researcher gets the clue about related parameters, boundary condition which was used in previous papers or by former researchers. Idea is obtain related to the techniques used by former's. Materials is collected from journals, internet etc. By the time review will complete, outline is form about all the researches like about their outcomes, shortcomings of study and about future scope in every work. After this work will be start in the direction to give better solution.

A. *Measuring Instuments*

1) *Anemometer:* Digital Anemometer or wind meter is a small in size easy to use device. Anemometer consists of digital meter and vane wheel which is used to measure flow of any fluid generally air or gases. Vanes of vane will move proportional to the air which is flowing in front of vane wheel. It is also helpful in measuring temperature. Proximity switch is used in this device to sense velocity and the rotational direction of velocity. To construct a car cabin CAD file, accurate measurement has been taken. Measuring tape has used for measurement, care must be taken while measuring so that inside volume of car cabin as a result of that simulations will be accurate.

B. *Modeling*

1) *CAD Modeling:* CAD file is generated with the help of inventor software and save in STP format for further use in Fluent.

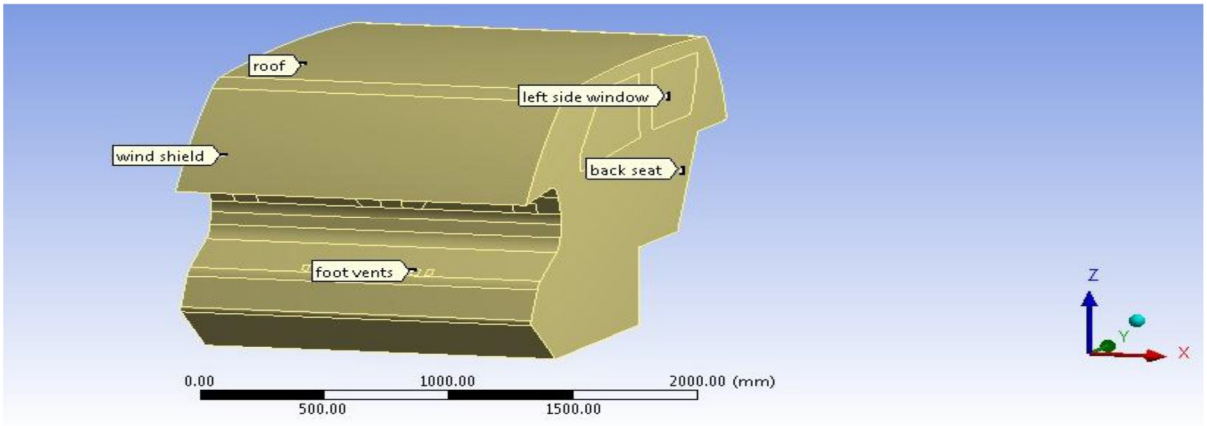
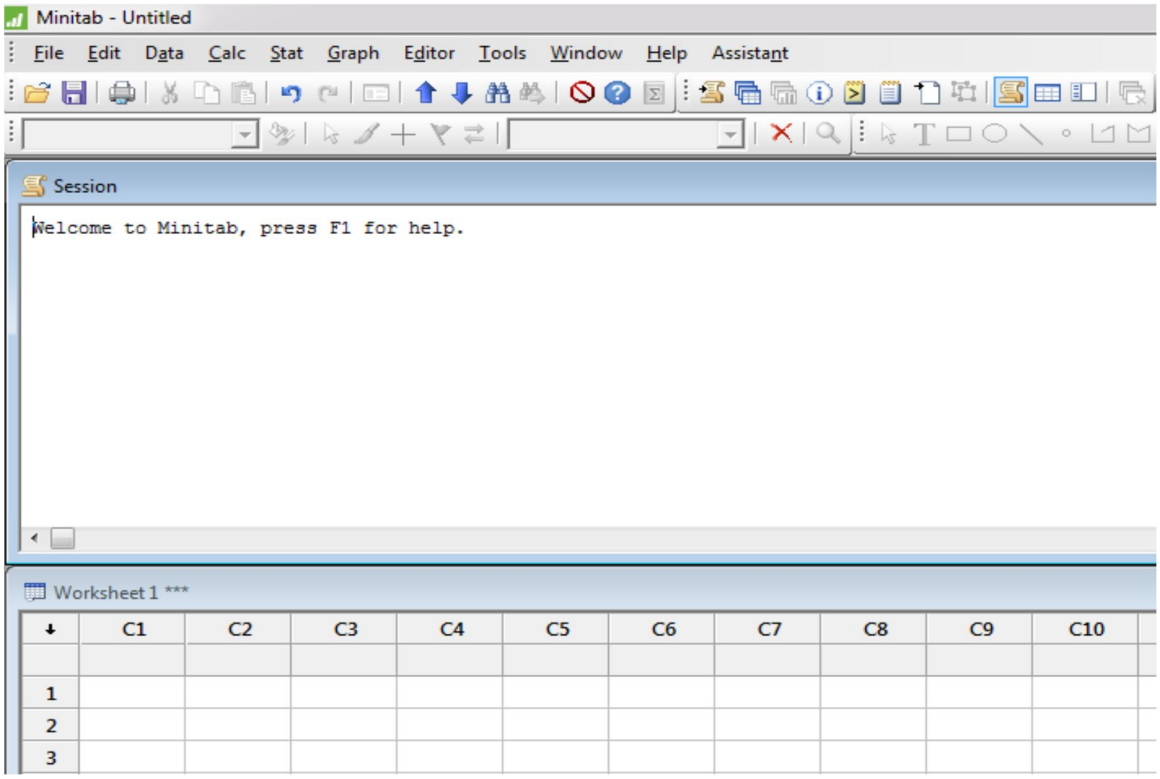
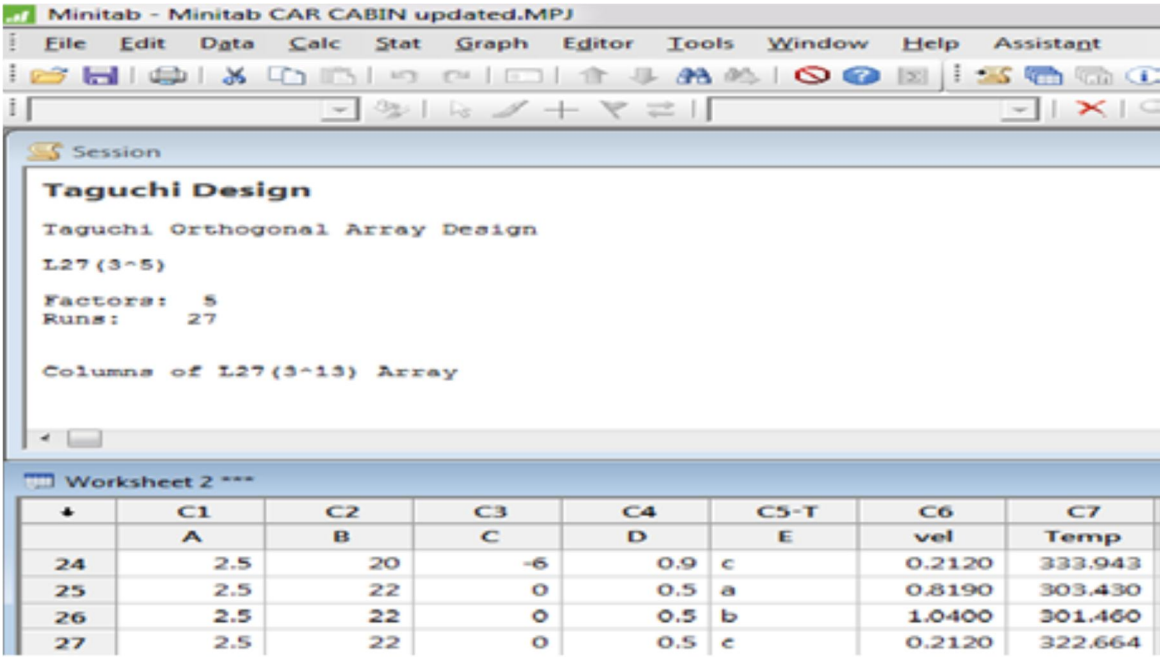


Fig:-CAD file of swift car

2) *ANOVA Analysis:* Results got from simulation is now used to get some significance with input parameter ANOVA is used to know that which case is best and which the worse. ANOVA also helps in finding the more crucial factor among the chosen and which level is best for particular factor. ANOVA analysis is a statistical tool which is used to analyze the difference between group mean. ANOVA tells the important factors by comparing response variable. it is also said that ANOVA is also used for optimization. Table will be import in MINITAB. MINITAB is the software used in this thesis for Taguchi method and ANOVA analysis. For ANOVA following steps are required.



Data from simulation is copied to the MINITAB worksheet. Now regression analysis will be performed over these simulation results data.



3) Regression Analysis: Regression analysis performed with respect to the factors. Responses and factors selection is essential to develop results from the simulation results. It is use to find relation between different variables.

- Step 1: Run the MINITAB software

Velocity versus A, B, C, D and E

Below table Analysis of Variance for velocity

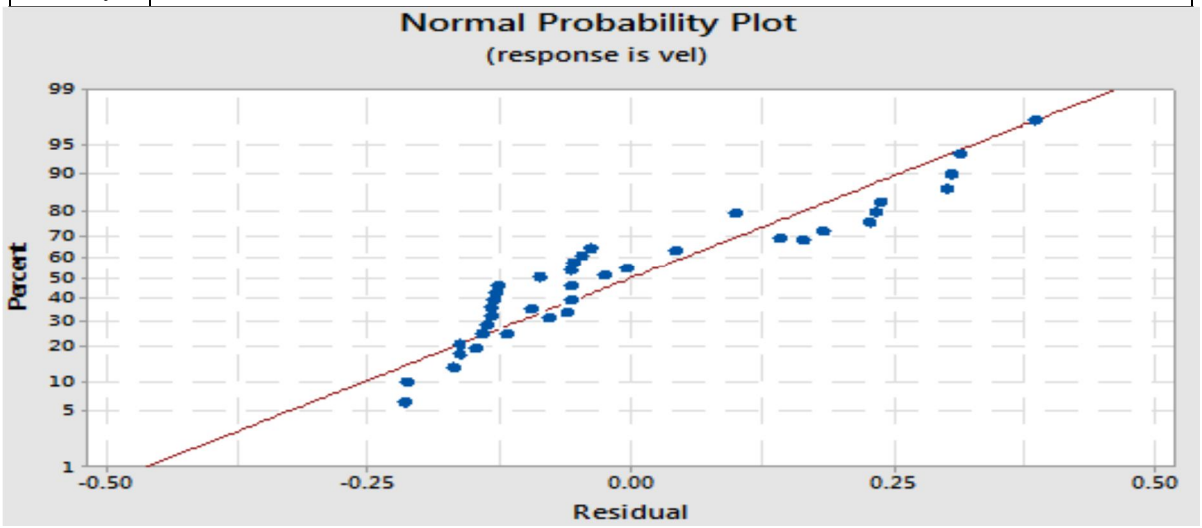
Source	DF	Adj SS	AdjMs	F value	P value
Regression	5	1.18531	0.237062	4.88	0.04
A	1	0.29376	0.293761	6.05	0.023
B	1	0.00002	0.000023	0.00	0.983
C	1	0.00025	0.000249	0.01	0.944
D	1	0.00039	0.000385	0.1	0.930
E	1	0.89098	0.890890	18.36	0.035
Error	1	1.01912	0.048529		
Total	26	2.20443			

Table :-Model Summary for velocity

S	R-sq	R-Sq(adj)	R-sq(pred)
0.220294	83.77	42.76	76.04

Regression Equation

Velocity	0.484 + 0.256 A - 0.0006 B - 0.00062 C - 0.023 D - 0.2225 E



Temperature versus A, B, C, D, E

Table for Analysis of Variance for temperature

Source	DF	Adj SS	AdjMs	F value	P value
Regression	5	3834.03	766.81	8.54	0.000
A	1	364.80	364.80	4.02	0.048
B	1	113.4	113.34	1.25	0.276
C	1	2.56	2.56	1.03	0.018
D	1	343.44	343.44	3.79	0.025
E	1	309.90	309.90	3.18	0.34
Error	1	1905.28			
Total	26	5739.91			

Table :-Model Summary for temperature

S	R-Sq	R-Sq(Adj)	R-sq(pred)
9.52510	86.80%	58.90%	87.64%

Regression Equation

Temperature	267.4 - 9.00 A + 1.25 B + 0.063 C + 21.8 D + 12.93

III. RESULTS AND DISCUSSION

Hatchback cars in India generally have uneven cooling. Therefore thermal comfort draws attention of companies. Hatchback cars designed by company are always economical but companies always compromise with thermal comfort. Today companies are tried to give better thermal comfort. Actually in India rules are not strictly followed by companies with respect to thermal comfort. In this work various parameters are alter for the betterment of thermal comfort ANSYS Fluent was used for simulation purpose and steps were discussed in previous chapters. ANOVA analysis performed with the help of MINITAB software. All the simulation data are transfer to MINITAB. ANOVA is used to analyze data for more than two samples. Taguchi method is used formation of orthogonal array Orthogonal array consist 27 cases. These all cases will not be described. So, selected cases will be discussed here. ANOVA analysis is followed by regression analysis. For each factors three conditions has been used and form 27 cases by sampling process. Than with the help of analysis of variance researcher found the critical input factors which plays an important in changing the comfort. Air velocity and air temperature were selected as two response factor used in statistical analysis. S/N ratio is beneficial for analysis because it can observe combined effect of no of factors.

Factors	Level		
1 Air velocity	1.5	2	25
2 Air temperature	18	20	22
3 Vane angle	-6	0	+6
4Glass transmissivity	0.5	0.7	0.9
5 Inlet Position	1	2	3

Air velocity – m/s , Air temperature - oC , Vane angle – degree.
Factors: These are the features which can changes the responses of simulation. Initially factors are assumed firstly or can get idea from literature survey.
Levels: These are the number of values given to the factors.

IV. CONCLUSION

Objective of this thesis is to increase thermal comfort of hatchback car cabin. Thermal comfort can be change by various parameters such as air velocity, air temperature, humidity and many more. Taguchi method is used to form an orthogonal array from different factors and levels. So Taguchi gives 27 cases. By the help of experimental design no of cases were obtain than with the help regression relation between parameter found.

Level	A	B	C	D	E
1	-4.647	-4.611	-4.554	-4.622	-4.593
2	-4.633	-4.607	-4.652	-4.622	-4.545
3	-4.569	-4.632	-4.643	-4.607	-4.711
Delta	0.077	0.025	0.098	0.015	0.165
Rank	3	4	2	5	1

From the above table it is concluded that Factor E is the most manipulating factor. After than C is the main factor that means the vane angle. To achieve better thermal comfort these factor plays important role.

A. Model Equations

Model equations are generated with the help of MINITAB software for velocity, temperature and turbulence intensity. By the help of these equations we find value of average velocity, average temperature and turbulence intensity for further work by changing the values of these factors..

Regression Equation of velocity:

vel = 0.484 + 0.256 A - 0.0006 B - 0.00062 C - 0.023 D - 0.2225 E

Regression Equation of temperature:

Temp = 267.4 - 9.00 A + 1.25 B + 0.063 C + 21.8 D + 12.93

V. ACKNOWLEDGEMENTS

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REFERENCES

[1] Hussain H. Al-Kayiem, M. Firdaus Bin M. Sidik and Yuganthira R.A.L Munusammy, Study on the Thermal Accumulation and Distribution inside a Parked Car Cabin, American Journal of Applied Sciences, 2010, 7 (6): 784-789.
[2] Ali Alahmer, Mahmoud Abdelhamid, Mohammed Omar, Design for thermal sensation and comfort states in vehicles cabins, Applied Thermal Engineering 36 (2012), 126-140.
[3] Hamid Khayyam, SaeidNahavandi, Eric Hu, Abbas Kouzani, Ashley Chonka, JemalAbawajy, Vincenzo Marano, Sam Davis, Intelligent energy management control of vehicle air conditioning via look-ahead system, Applied Thermal Engineering 31 (2011) 3147-3160.
[4] Ali Alahmer, Mohammed Omar, Abdel RaoufMayyas, AlaQattawi, Analysis of vehicular cabins' thermal sensation and comfort state, under relative humidity and temperature control, using Berkeley and Fanger models, Building and Environment 48 (2012) 146-163.
[5] Ivanescu, Mariana, Neacsu, Catalin, Tabacu, Stefan, Tabacu, Ion, The Human Thermal Comfort Evaluation inside the passenger compartment, F2010-C-044.
[6] Guodong Yea, Changzhi Yang, Youming Chen, Yuguo Li, A new approachfor measuring predicted mean vote (PMV) and standard, Building and Environment 38 (2003) 33 – 44.
[7] A. Mezrhab, M. Bouzidi, Computation of thermal comfort inside a passenger car compartment, Applied Thermal Engineering 26 (2006) 1697–1704.
[8] Omer Kaynakli, MuhsinKilic, Investigation of indoor thermal comfort under transient conditions, Building and Environment 40 (2005) 165–174.
[9] Huajun Zhang, Lan Dai, GuoquanXu, Yong Li, Wei Chen, Wen-Quan Tao, Studies of air-flow and temperature fields inside a passenger compartment, Applied Thermal Engineering 29 (2009) 2022–2027.
[10] Mingyu Wang, Edward Wolfe, and DebashisGhosh, Localized Cooling for Human Comfort, SAE International 2014-01-0686.
[11] DraganRuzic and FerencCasnji, Thermal Interaction Between a Human Body and a Vehicle Cabin, 2010, 5772/51860
[12] Ali Alahmer, Mohammed omar, vehicular cabins thermal comfort zones; Fanger and Berkley modeling, Vehicle Engineering (VE) Volume 1 Issue 1, March 2013.
[13] A. Melikov, T. Ivanova, G. Stefanova, Seat headrest-incorporated personalized ventilation: Thermal comfort, Building and Environment 47 (2012) 100-108.
[14] DoruConstantin, MihaiNagi, Crisanta-AlinaMazilescu, Elements of Discomfort in Vehicles, Social and Behavioral Sciences 143 (2014) 1120 – 1125.
[15] Uzeyir Pala, H. Ridvan Oz, An investigation of thermal comfort inside a bus during heating period within a climatic chamber, Applied Ergonomics 48 (2015) 164-176.
[16] Joel M. Devonshire, James R. Sayer, Radiant Heat and thermal comfort in vehicles, The University of Michigan, Ann Arbor, Michigan 48109-2150
[17] ASHRAE American Society of Heating Refrigerating and Air Conditioning Engineers, Standard 55, ―Thermal Environmental Conditions for Human Occupancy‖, Atlanta, 1992.

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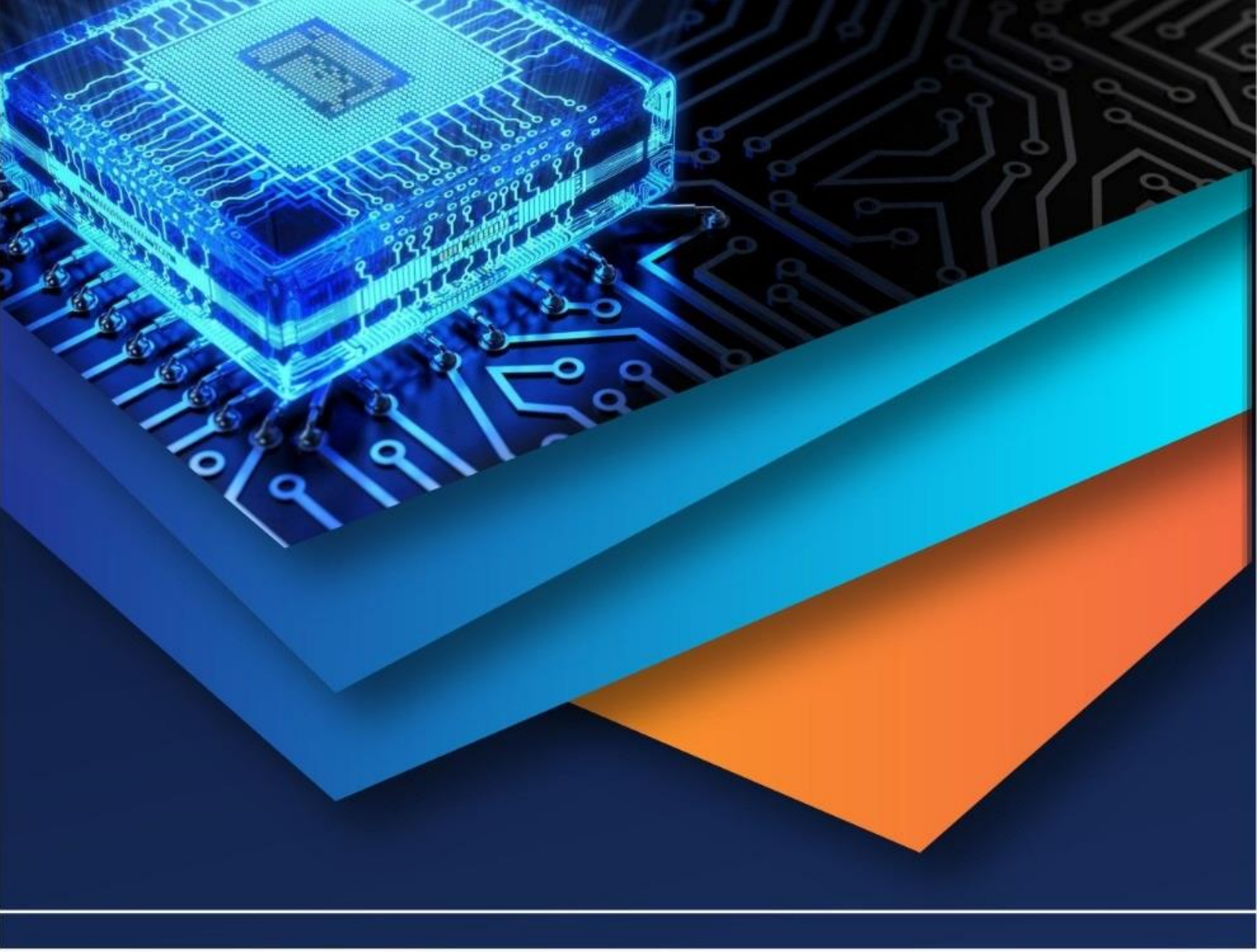

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