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Determining the PM_{10} and $PM_{2.5}$ Concentrations in Prayagraj City due to Solid Waste Burning using AERMOD

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Abstract: Open burning of municipal solid waste (MSW) is a poorly-characterized and frequently-underestimated source of air pollution in developing countries. This paper estimates the air pollution happening from MSW burning in municipality areas of the Prayagraj, Uttar Pradesh, India. Air quality models (AQMs) are critical components for urban air quality management because they can predict and forecast air pollutant concentrations. Advanced AQM, such as AERMOD, has a well-established application in the developed world provided sufficient input data is available. However, in poor countries, it is limited due to a lack of adequate and trustworthy data. The present study is focused to assess the urban air quality due to municipal solid waste burning around a Sangam city Prayagraj in India using dispersion modelling.
Keywords: PM10, PM2.5, Air Quality Modelling, AERMOD

I. INTRODUCTION

Prayagraj is one of India's ancient cities. it is known as ‘Prayag' or ‘Teertharaj' in ancient scriptures and is considered India's holiest pilgrimage site. MSWM is a serious issue for towns because it requires a significant investment and receives little attention. it's not only a technological issue; political, legal, socio-cultural, environmental, and economic concerns, as well as available resources, all play a role. many cities in developing Asian countries have major solid waste management issues. annual trash creation rises in lockstep with population and urbanisation, and disposal challenges have gotten more difficult as more land is required for final disposal of these solid wastes. in many Indian cities and towns, MSW is typically disposed of in an open dump, which is not the right method of disposal because such crude dumps pose environmental concerns, generating ecological imbalances in terms of land, water, and air pollution. the future MSW generation rate in Indian cities will be accelerated by rising population levels, rapid economic expansion, and rising community living standards. in India, more than 90% of MSW is disposed of in an unsatisfactory manner directly on the ground. the situation is already severe in cities and towns, where trash disposal systems are unable to keep up with the volume of waste created. large mountains of waste can be seen in every nook and cranny of cities, piled up in an unorganised fashion. using a dispersion model, the current study seeks to determine the air pollution generated by burning MSW and to highlight the major polluting locations of Prayagraj city. AERMOD view, a complete and powerful air dispersion modelling software that seamlessly includes the US EPA's chosen regulatory air dispersion model into a powerful, easy-to-use interface, was utilised as a dispersion model in this study. the AMS/EPA regulatory model (AERMOD) is a steady-state gaussian air dispersion model based on planetary boundary layer theory that is the state-of-the-art. the prime building downwash algorithms, sophisticated depositional parameters, local terrain and urban heat island effects, and advanced meteorological turbulence computations are all completely integrated into AERMOD.

II. STUDY AREA

Allahabad is situated in the southern region of the Indian state of Uttar Pradesh, at 25.308 N latitude and 81.558 E longitude, at a height of 88.0 metres above sea level (Figure 1). The GMT time zone is 5.5 hours. It is bordered by Pratapgarh in the north, Jaunpur in the north east, Varanasi in the east, Mirzapur in the south, Naini in the south-west, Chitrakot in the south-west, and Kaushambi in the west. A part of the Ganga–Yamuna Doaba region, it is the last point of the Yamuna River. As per information provided by Allahabad Nagar Nigam, the city encompasses an area of 70.05 sq.km approximately and as per census 2001 the population of the city was about 1.1 million (1,112,544). Twenty-three important localities of Prayagraj were choose that were under the municipal boundaries of Prayagraj. The areas were then marked on digital map using google earth. The 3x3 grid map of Prayagraj was then been constructed using GIS tool.

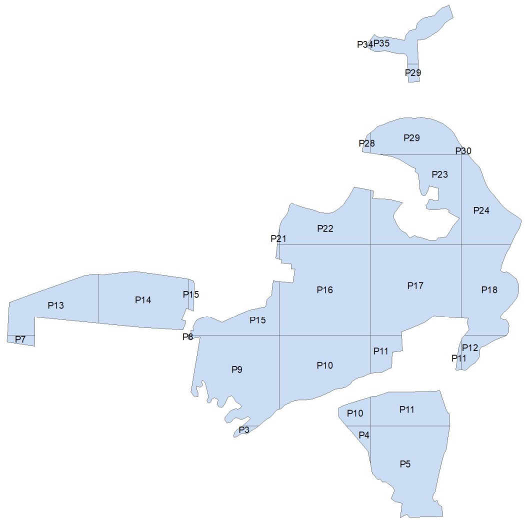

Fig.1 3x3 Grid Map of Prayagraj

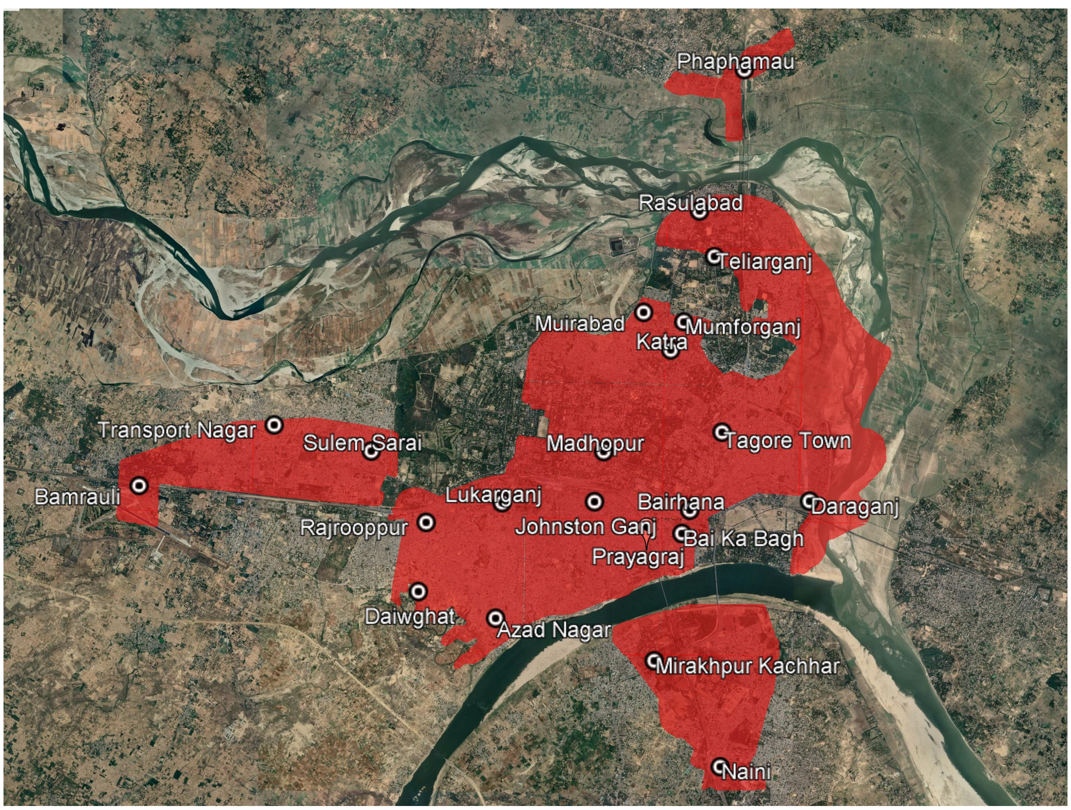

Fig. 2 Municipal Areas of Prayagraj

III.METHODOLOGY.

A. *Data Collection*

All the municipal data and the population data were taken from the government portals and census data of year 1991, 2001, 2011 were used to calculated the forecasted population of the year 2021 using the incremental increase method. The ward wise population of Prayagraj were then extracted from the census data to calculated the MSW generation and burning. Emission factors for calculating the emissions were taken from the CPCB's report.

B. Meteorological Data

All the meteorological data were taken between the time span of 1st October 2020 to 31st December 2020, and were used to develop the model. The dispersion of air pollutants and particle deposition are influenced by weather conditions. The selected domain of Prayagraj's hourly surface data, upper air data, land use, and land cover data were then collected. The location of Prayagraj was precisely retrieved from Google Earth for the modelling study. Because the land is nearly flat, simple terrain was expected. The addition of receptors to the sampling points aided the model validation process and provided appropriate resolution for the investigation. A grid cover of 20 km × 20 km area were then been taken.

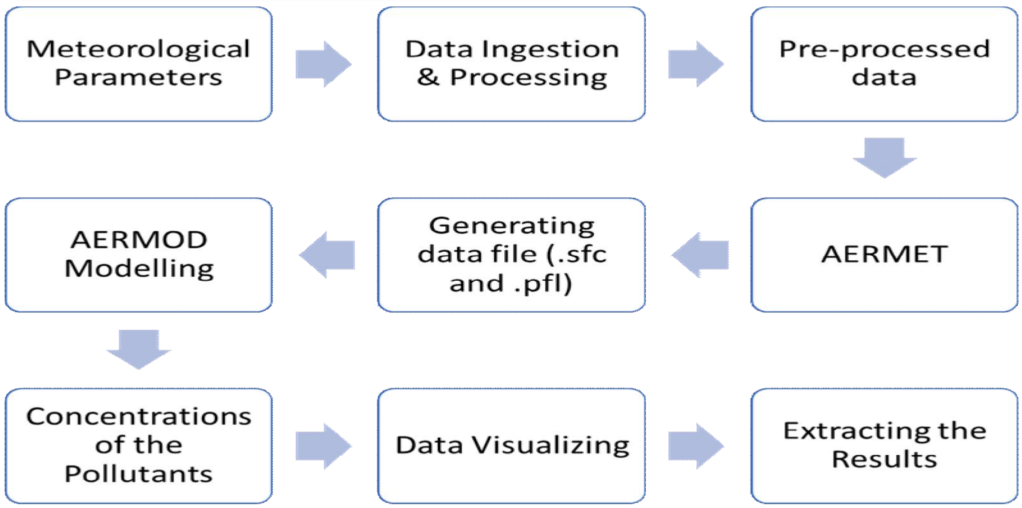

Fig. 3 Flowchart of AERMOD

AERMET is an AERMOD meteorological data pre-processor. AERMET develops two files: a surface data file and a profile data file, from commercially available or custom on-site met data. AERSURFACE is a tool that can be used to estimate surface characteristics for use in AERMET.

C. Input Data for Model

All the emission data of grid wise MSW burning is then feeded in the model in gm/sec. The mean sea level of Prayagraj were been taken as 88 metres.

IV. RESULTS

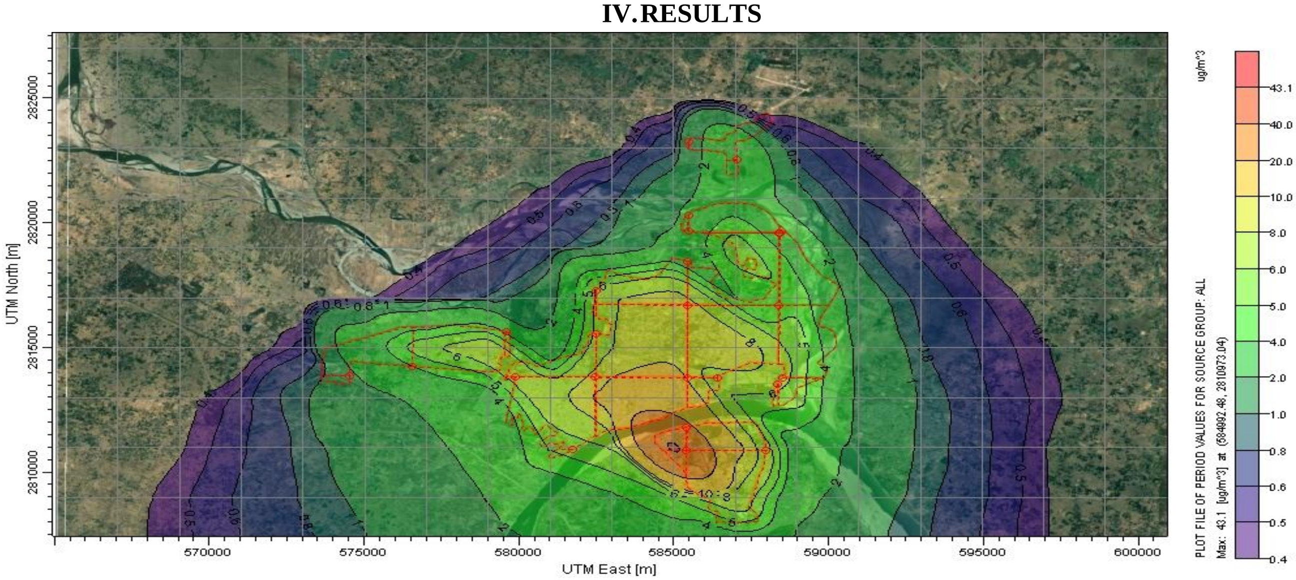

Fig. 4 AERMOD Results of PM_{10}

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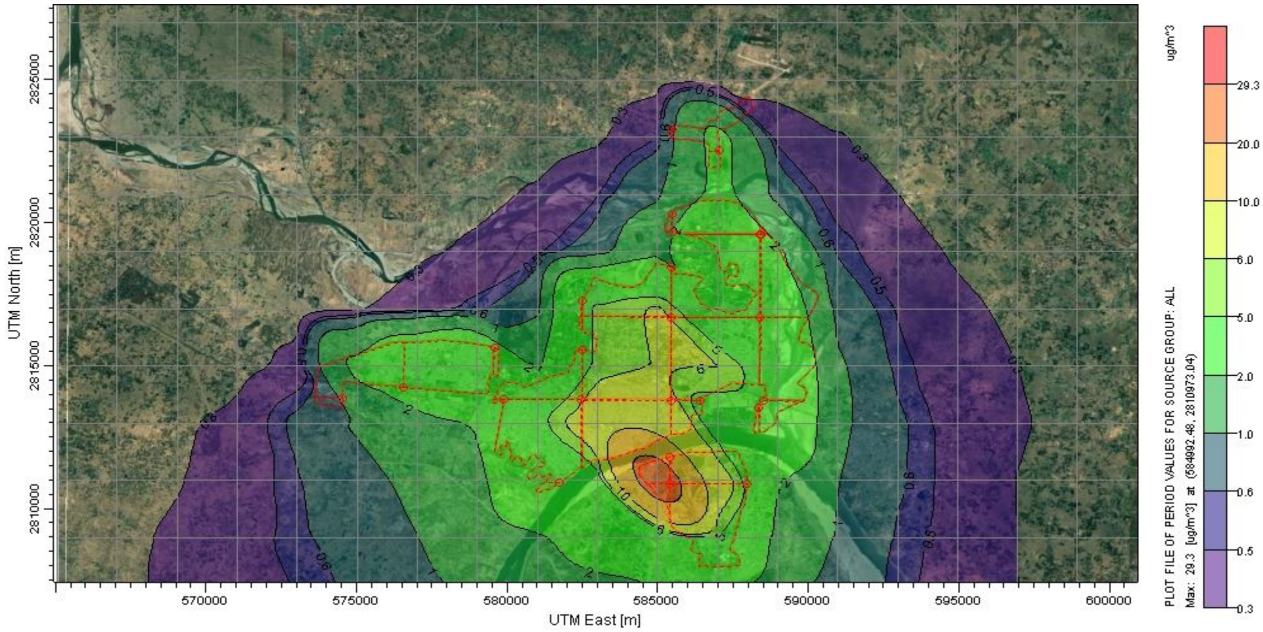

Fig. 5 AERMOD Results of $PM_{2.5}$

Figure 6 and 7 shows the area-wise PM10 and PM2.5 concentrations in Prayagraj, whereas the Table.1 shows the emissions vs concentraction values. It can be seen from the results that the places with lesser amount of emissions may have higher amount of concentrations due to pollution dispersing patterns and metereological factors involvement.

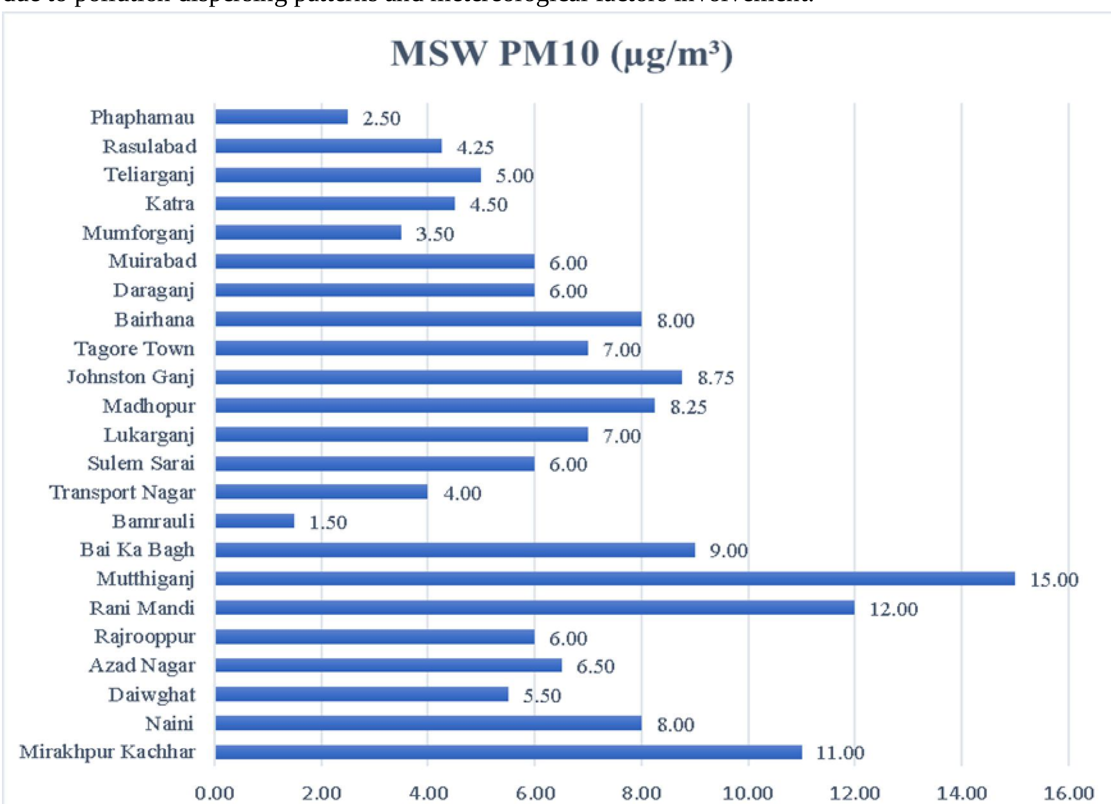

Fig.6 PM_{10} Concentrations in Important Localities of Prayagraj

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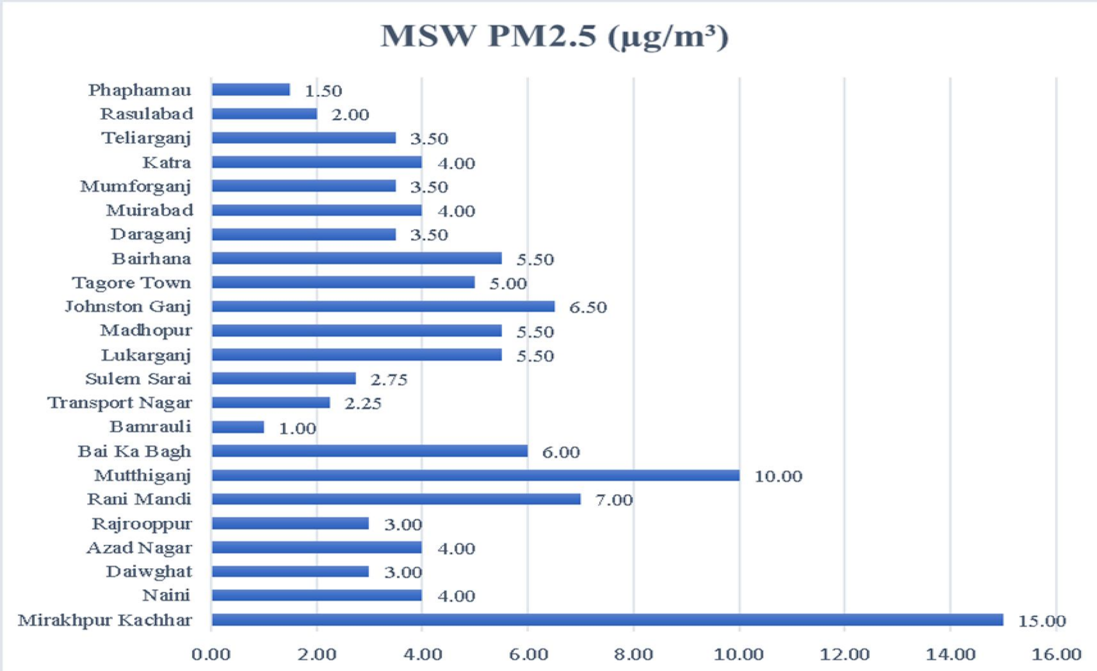

Fig.7 $PM_{2.5}$ Concentrations in Important Localities of Prayagraj

Table.1. Area-wise Emission vs Concentration Results

Areas of Prayagraj	Grid No.	PM10 Emission (gm/sec)	PM2.5 Emission (gm/sec)	PM10 Concentration (µg/m³)	PM2.5 Concentration (µg/m³)
Mirakhpur Kachhar	P4	0.012584516	0.008557471	11.00	15.00
Naini	P5	0.458016459	0.311451192	8.00	4.00
Daiwghat	P9	0.512823612	0.348720056	5.50	3.00
Azad Nagar	P9	0.512823612	0.348720056	6.50	4.00
Rajrooppur	P9	0.512823612	0.348720056	6.00	3.00
Rani Mandi	P10	0.809810871	0.550671392	12.00	7.00
Mutthiganj	P10	0.809810871	0.550671392	15.00	10.00
Bai Ka Bagh	P11	0.380174753	0.258518832	9.00	6.00
Bamrauli	P13	0.242037764	0.164585679	1.50	1.00
Transport Nagar	P14	0.509177289	0.346240556	4.00	2.25
Sulem Sarai	P14	0.509177289	0.346240556	6.00	2.75
Lukarganj	P15	0.209299458	0.142323631	7.00	5.50
Madhopur	P16	0.808737146	0.54994126	8.25	5.50
Johnston Ganj	P16	0.808737146	0.54994126	8.75	6.50
Tagore Town	P17	0.937314706	0.5417679	7.00	5.00
Bairhana	P17	0.937314706	0.5417679	8.00	5.50
Daraganj	P18	0.247975606	0.168623412	6.00	3.50
Muirabad	P22	0.53032365	0.360620082	6.00	4.00
Mumforganj	P23	0.423910311	0.288259011	3.50	3.50
Katra	P23	0.423910311	0.288259011	4.50	4.00
Teliarganj	P23	0.423910311	0.288259011	5.00	3.50
Rasulabad	P29	0.439595311	0.298924811	4.25	2.00
Phaphamau	P35	0.129944975	0.088362583	2.50	1.50

V. CONCLUSION

Despite the fact that PM_{10} and $PM_{2.5}$ pollution was ubiquitous throughout the city, the greatest average PM_{10} and $PM_{2.5}$ concentrations were found in Mutthiganj and Mirakhpur Kachhar, respectively. The study focused on using AERMOD to estimate urban air quality in Prayahraj, Uttar Pradesh, India, due to MSW burning. This research presents an integrated approach for evaluating AERMOD's performance in Indian meteorological conditions, as well as quantifying source contributions and the efficacy of management practises in reducing pollution levels.

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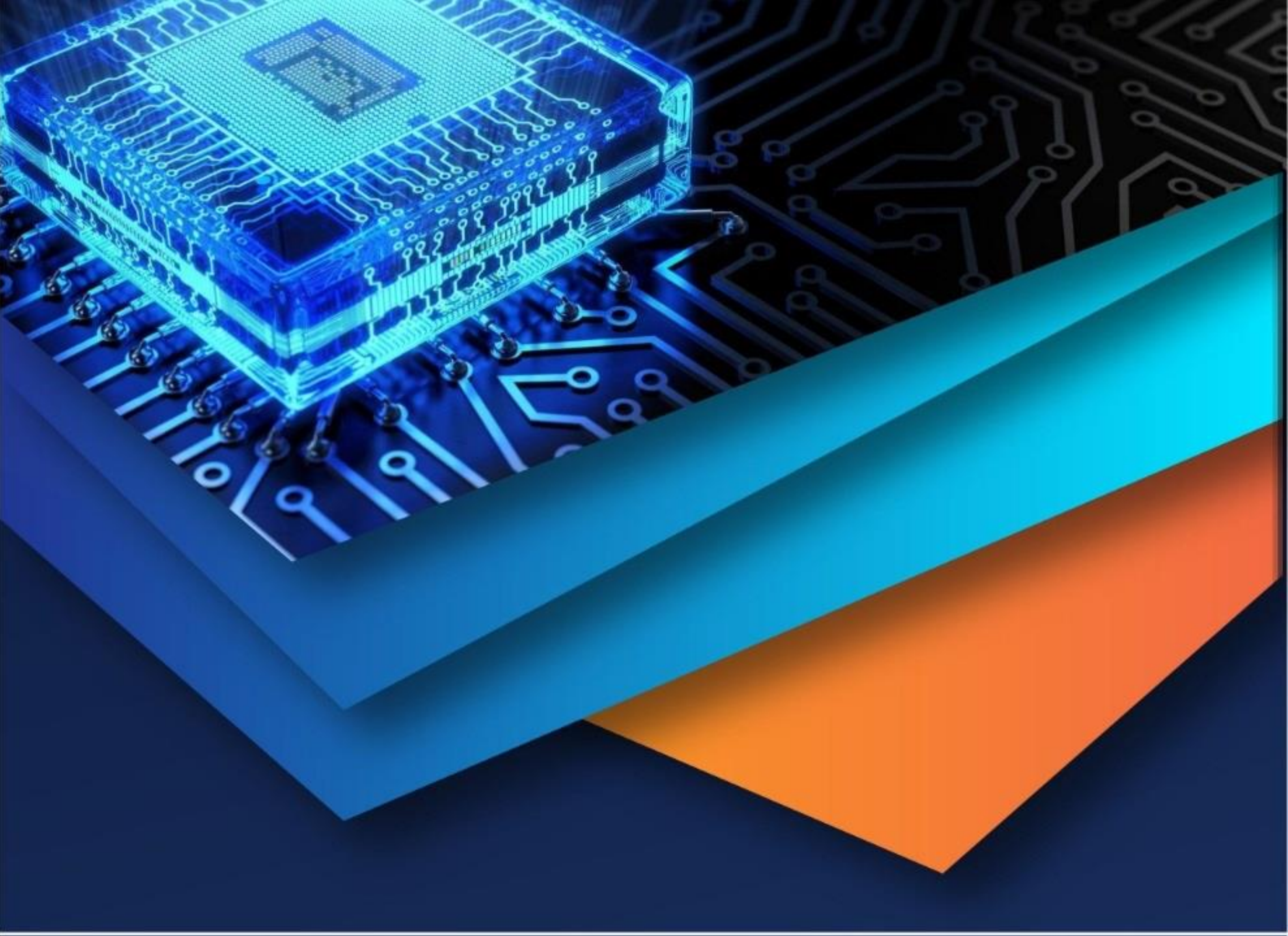

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