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Comparative Analysis of Groundwater Quality near a Dumping Ground in Garchuk Area, Guwahati

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Abstract: This project focuses on analyzing and comparing the water quality of a dumping ground, nearby residential area, and commercial area in Garchuk, Guwahati. Water samples were collected from these three locations using tube wells and various parameters were assessed to evaluate the water quality. The analysis included the measurement of Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD). The Winkler method was employed for DO analysis, involving the oxidation of divalent manganese hydroxide precipitate by dissolved oxygen in the water sample. The BOD determination assessed the oxygen required for the biochemical degradation of organic material during a specified incubation period. Results from the DO analysis indicated varying levels of dissolved oxygen in the water samples collected from the dumping ground, residential site, and commercial site. BOD analysis revealed the oxygen utilization and degradation of organic material in the water samples after a 5-day incubation period. Additionally, the concentrations of heavy metals such as lead (Pb), arsenic (Ar), zinc (Zn), copper (Cu), and mercury (Hg) were analyzed in the groundwater samples. The results showed that some heavy metal concentrations were below the detectable limit, while others exhibited measurable levels. The findings of this study provide valuable insights into the water quality of the studied areas, indicating potential pollution levels and the effectiveness of waste treatment processes. These results contribute to better understanding and management of water resources in the Garchuk area, helping to protect the environment and public health.
Keywords: Water quality, dumping ground, residential area, commercial area, dissolved oxygen, biochemical oxygen demand.

I. INTRODUCTION

Water, a vital resource essential for our daily lives, exists in two primary forms: ground and surface water. From domestic to industrial applications, water plays a fundamental role in various aspects of our existence, including agriculture, transportation, and healthcare (Winter *et al*., 1998). In developing nations, small households and communities rely heavily on groundwater, while larger urban areas and communities depend on surface water sources like rivers and lakes, often treated in specialized facilities. However, the contamination of these crucial water sources poses a significant threat, rendering them unfit for consumption and presenting challenges in terms of cost and treatment.

Solid waste management presents a formidable challenge in numerous countries, particularly in developing nations experiencing rapid population growth. In such regions, solid waste is commonly disposed of in engineered or non-engineered landfill sites (Yan *et al*., 2010; Rana *et al*., 2018; Sharma et al., 2019). Improper handling and operation of landfills can have severe environmental repercussions, including fires, vegetation damage, noxious odors, soil contamination, groundwater and air pollution, as well as the emission of greenhouse gases such as methane (Calvo *et al*., 2005; Aziz *et al*., 2015; Sharma *et al*., 2019). The composition and quantity of leachate and gases produced in landfills greatly influence the magnitude of this menace (Talalaj *et al*., 2016).

When waste materials are deposited in landfills, they become susceptible to the infiltration of groundwater due to precipitation or erosion, resulting in the percolation of water through the waste. This process leads to the collection of various colloidal inorganic and organic compounds, forming a contaminated liquid known as leachate, which subsequently permeates the soil, surface water, and groundwater surrounding the landfill site (Lone *et al*., 2012; Bhalla *et al*., 2012). Leachate formation involves a combination of chemical, physical, and microbial processes within the dumped waste (Kjeldsen *et al*., 2010). The exposure of groundwater to leachate is further heightened during periods of excess rainfall (Nagarajan et al., 2012). Leachate often contains organic matter, inorganic salts, and heavy metals (Mojiri *et al*., 2014; Rana *et al*., 2018), with the specific constituents influenced by the age of the landfill and the degree of waste stabilization (Talalaj *et al*., 2016). Unfortunately, biological methods of leachate stabilization have proven less effective due to slow reaction kinetics, exacerbating the adverse effects on the environment (Kulikowska *et al*., 2019).

The generation of unpleasant odors from leachate, landfill gases, and deposited materials remains a significant concern associated with landfills (Maheshwari *et al*., 2015; Rana *et al*., 2018; Sharma *et al*., 2019). The health and environmental risks posed by landfills necessitate proper management and operation. Consequently, extensive research has been conducted to examine the effects of waste landfill on both human health and the environment (Cumar *et al*., 2011; Singh *et al*., 2016; Rana *et al*., 2018; Sharma *et al*., 2019). For instance, Rana *et al*. (2018) conducted a study in India, evaluating the leachate pollution index (LPI) and water quality index (WQI) for different landfill sites, and their findings revealed significant contamination in generated leachate and improved groundwater quality with increasing distances downwind.

II. MATERIALS AND METHODS

The collection of water samples involves selecting specific sites and using tube wells to extract groundwater samples. In this particular study, water samples are collected from three locations: the dumping ground of Guwahai Municipal Corporation (GMC), Guwahati near Gorchuk, a nearby residential site, and a commercial site near the dumping ground. The tube wells are pumped for approximately 10 minutes to ensure water is collected from the ground level. To preserve the integrity of the samples, they are immediately acidified on-site, and the acidity is checked using pH paper, which turned light pink to indicate acidity. The acidified water samples are then stored in appropriate containers for further analysis.

Dissolved Oxygen (DO) analysis is a crucial test in water pollution assessment and waste treatment process control. The Winkler method is used for DO analysis due to its precision and reliability. This method involves the addition of divalent manganese solution followed by strong alkali to the water sample in a glass stopper bottle. The dissolved oxygen present in the sample rapidly oxidizes the divalent manganese hydroxide precipitate to higher valency states. In the presence of iodide ions in an acidic solution, the oxidized manganese reverts to the divalent state, releasing iodide equivalent to the original dissolved oxygen content. The iodide is then titrated using a standard solution of thiosulphate.

The apparatus required for DO analysis includes a 300ml BOD bottle, conical flask, burettes, pipettes, and a measuring cylinder. Reagents such as standard manganous sulphate solution, alkali-iodide-azide reagent, standard sodium thiosulphate titrant, starch solution, and concentrated sulphuric acid are used in the analysis. The procedure involves adding specific volumes of reagents to the water sample, allowing the precipitate to settle, adding concentrated sulphuric acid, transferring a portion of the sample to a conical flask, and conducting the titration using sodium thiosulphate. The difference between the initial and final burette readings provides the amount of sodium thiosulphate consumed during titration, which corresponds to the dissolved oxygen content in the sample.

The Biochemical Oxygen Demand (BOD) determination is an empirical test used to measure the oxygen requirements of wastewater and assess the efficiency of treatment systems. The test measures the oxygen utilized during a specified incubation period for the biochemical degradation of organic material. It also accounts for the oxidation of reduced forms of nitrogen, unless inhibited. The method involves filling airtight BOD bottles with the water sample and incubating them at a specified temperature for 5 days. The initial and final dissolved oxygen levels are measured, and the BOD is calculated by subtracting the initial DO from the final DO.

For the BOD analysis, the required apparatus includes 300 ml BOD bottles, conical flasks, burettes, pipettes, and concentrated sulphuric acid. The necessary reagents consist of standard manganese sulphate solution, alkali-iodide-azide reagent, standard sodium thiosulphate solution, starch solution, and concentrated sulphuric acid. The procedure involves measuring the initial DO of the sample using a standard method, incubating the BOD bottles for 5 days at the specified temperature, and determining the final DO after incubation. The BOD is then calculated by subtracting the initial DO from the final DO, taking into account the dilution of the sample.

These methods and methodologies provide a standardized approach for water sampling and analysis, allowing for the assessment of parameters such as dissolved oxygen and biochemical oxygen demand. By following these procedures, researchers and environmental scientists can gain insights into water pollution levels and the effectiveness of waste treatment processes, thereby contributing to the management and protection of water resources.

III. RESULTS

The water samples from different sources were subjected to analysis, and the results were documented in a table. To ensure accuracy, multiple tests were conducted for each water source. However, the measured concentration values alone do not provide information about the potential toxic effects of certain heavy metals, as these effects can depend on the interactions between different metals. Therefore, it is important to understand how these heavy metals interact with various elements to fully assess their impact.

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A. *Dumping Ground Sample Observation*

Table I: Observation Table of DO of Dumping Ground Sample

Sl. No.	Bottle No.	Initial volume ml	Final volume ml	Difference	Dissolved oxygen mg/L
1	1	0	5.1	5.1	
2	2	5.1	10.3	5.2	5.1
3	3	10.3	15.4	5.1	

Calculations:
1 ml of 0.025M Na2S203 = 1 mg DO/L
Therefore, 5.1 ml of 0.025M Na2S2O3 = 5.1 mg DO/L
Result: The calculated Dissolved Oxygen is 5.1 mg/L.

B. *Commercial Site Sample Observation*

Table II: Observation Table of DO of Commercial Site Sample

Sl. No.	Bottle No.	Initial volume in ml	Final volume in ml	Difference	Dissolved oxygen in mg/L
1	1	0	3.7	3.7	
2	2	3.7	7.4	3.7	3.7
3	3	7.4	11.2	3.8	

Calculations:
1 ml of 0.025M Na2S203 = 1 mg DO/L
Therefore, 3.7 ml of 0.025M Na2S2O3 = 3.7 mg DO/L
Result: The calculated Dissolved Oxygen is 3.7 mg/L

C. *Residential Site Sample Observation*

Table III: Observation Table of DO of Residential Site Sample

Sl. No.	Bottle No.	Initial volume in ml	Final volume in ml	Difference	Dissolved oxygen in mg/L
1	1	0	3.2	3.2	
2	2	3.2	6.4	3.2	3.2
3	3	6.4	9.5	3.1	

Calculations:1 ml of 0.025M Na2S203 = 1 mg DO/L.
Therefore, 3.2 ml of 0.025M Na2S2O3 = 3.2 mg DO/L
Result: The calculated Dissolved Oxygen is 3.2 mg/L

D. *Dumping Ground Sample*

BOD 1st Day = Sample 100 ml

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Table IV: Observation Table for BOD of 1st Day of Damping Ground Sample

Sl. No.	Bottle No.	Initial volume in ml	Final volume in ml	Difference	Dissolved oxygen in mg/L (D1)
1	1	0	5.1	5.1	
2	2	5.1	10.3	5.2	5.1
3	3	10.3	15.4	5.1	

Calculations: 1 ml of 0.025M Na2S203 = 1 mg DO/L
Therefore, 5.1 ml of 0.025M Na2S2O3 = 5.1 mg DO/L
BOD 5th Day = Sample 100 ml

Table V: Observation Table for BOD of 5th Day of Damping Ground Sample

Sl. No.	Bottle No.	Initial volume in ml	Final volume in ml	Difference	Dissolved oxygen in mg/L (D2)
1	1	0	3.5	3.5	
2	2	3.5	7.1	3.6	3.5
3	3	7.1	10.6	3.5	

Calculations: BOD = (5.1 - 3.5)/1 = 1.6 mg/L
Result: The Biochemical Oxygen Demand of the water sample after incubating at 20 degree centigrade for 5 days is 1.6 mg/L

E. Residential Site Sample

BOD 1st Day = Sample 100 ml

Table VI: Observation Table for BOD of 1st Day of Residential Site Sample

Sl. No.	Bottle No.	Initial volume in ml	Final volume in ml	Difference	Dissolved oxygen in mg/L (D1)
1	1	0	3.2	3.2	
2	2	3.2	6.4	3.2	3.2
3	3	6.4	9.5	3.1	

Calculations: 1 ml of 0.025M Na2S203 = 1 mg DO/L
Therefore, 3.2 ml of 0.025M Na2S2O3 = 3.2 mg DO/L
BOD 5th Day = Sample 100 ml

Table VII: Observation Table for BOD of 5th Day of Residential Site Sample

Sl. No.	Bottle No.	Initial volume in ml	Final volume in ml	Difference	Dissolved oxygen in mg/L (D2)
1	1	0	1.9	1.9	
2	2	1.9	3.8	1.9	1.9
3	3	3.8	5.6	1.8	

Calculations: BOD = (3.2 – 1.9)/1 = 1.3 mg/L
Result: The Biochemical Oxygen Demand of the water sample after incubating at 20 degree centigrade for 5 days is 1.3 mg/L

F. Commercial Site Sample

BOD 1st Day = Sample 100 ml

Table VIII: Observation Table for BOD of 1st Day of Commercial Site Sample

Sl. No.	Bottle No.	Initial volume in ml	Final volume in ml	Difference	Dissolved oxygen in mg/L (D1)
1	1	0	3.7	3.7	
2	2	3.7	7.4	3.7	3.7
3	3	7.4	11.2	3.8	

Calculations: 1 ml of 0.025M Na2S203 = 1 mg DO/L
Therefore, 3.7 ml of 0.025M $Na_2S_2O_3$ = 3.7 mg DO/L
BOD 5th Day = Sample 100 ml

Table IX: Observation Table for BOD of 5th Day of Commercial Site Sample

Sl. No.	Bottle No.	Initial volume ml	Final volume ml	Difference	Dissolved oxygen in mg/L (D2)
1	1	0	2.3	2.3	
2	2	2.3	4.7	2.4	2.3
3	3	4.7	7.0	2.3	

Calculations: BOD = (3.7 – 2.3)/1 =1.4 mg/L
Result: The Biochemical Oxygen Demand of the water sample after incubating at 20 degree centigrade for 5 days is 1.4 mg/L

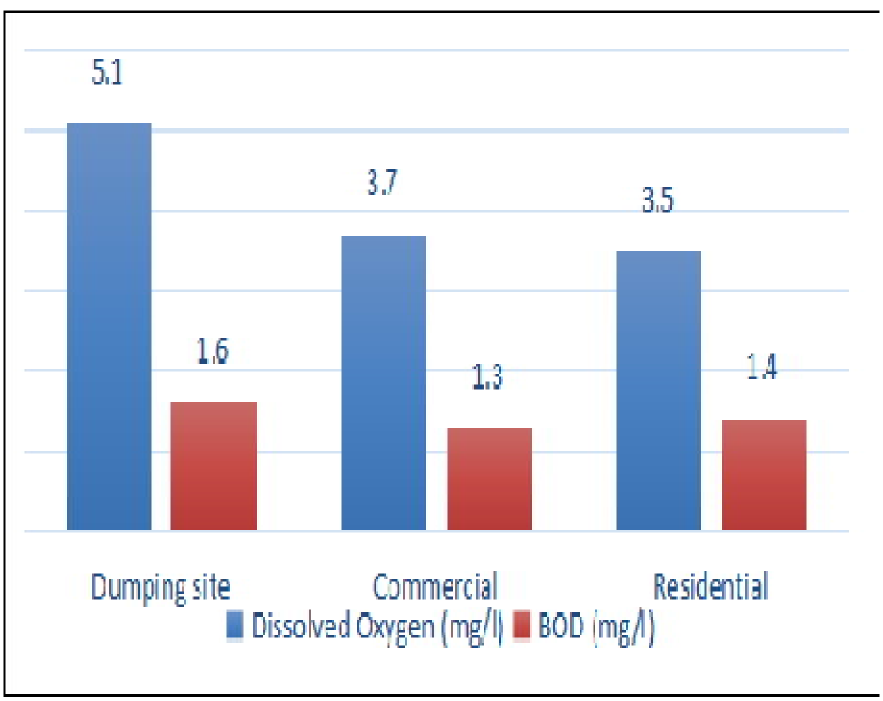

Chart 1: Concentration of DO and BOD of collected samples

G. Analysis report of groundwater samples.

Table X: Analysis report on groundwater samples

Sl. No.	Source	Pb (mg/l)	Ar (mg/l)	Zn (mg/l)	Cu (mg/l)	Hg (mg/l)
1	Ground water near garbage dumping site, Garchuk	BDL	0.013	0.074	BDL	BDL
2	Ground water from residential site near Garchuk	BDL	BDL	0.064	0.020	BDL
3	Ground water from commercial site near Garchuk	BDL	BDL	0.064	0.017	BDL

BDL: Below Detectable Limit

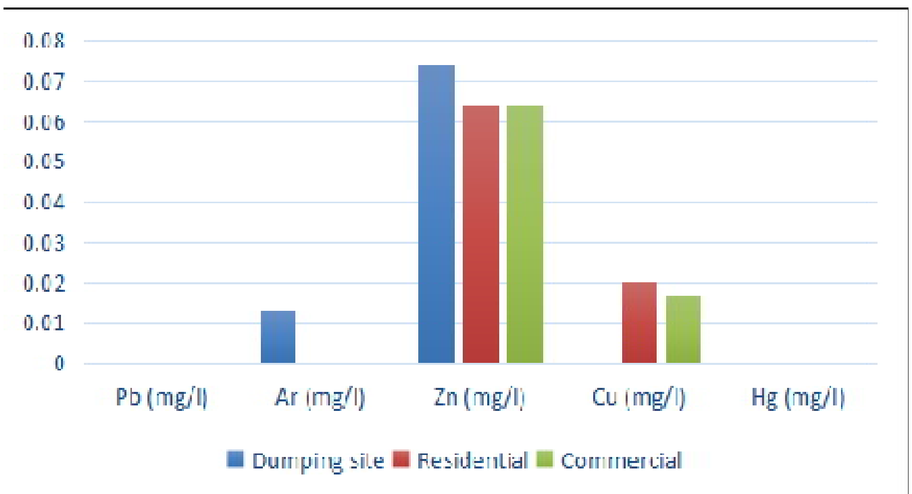

Chart 2: Concentration of heavy metals in collected samples

IV. CONCLUSIONS

In conclusion, the results obtained from the analysis of water samples collected from various sites in the Garchuk area provide valuable insights into the quality and potential risks associated with the water resources in this region. The measured parameters, including Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), and heavy metal concentrations, shed light on the environmental conditions and indicate the potential impacts on public health.

The calculated Dissolved Oxygen values for the samples collected from the dumping ground, commercial site, and residential site were 5.1 mg/L, 3.7 mg/L, and 3.2 mg/L, respectively. These results indicate variations in oxygen availability and suggest potential oxygen depletion in the water bodies near these sites.

Furthermore, the Biochemical Oxygen Demand (BOD) values obtained after incubating the water samples at 20 degrees Celsius for 5 days were 1.6 mg/L, 1.3 mg/L, and 1.4 mg/L for the dumping ground, commercial site, and residential site samples, respectively. These BOD values indicate the level of organic pollution present in the water, with higher values indicating higher levels of organic matter and potential water contamination.

Regarding heavy metal concentrations, the analysis revealed the presence of lead (Pb), arsenic (Ar), zinc (Zn), copper (Cu), and mercury (Hg) in the groundwater samples. The concentrations of these metals were found to be below the detectable limits (BDL) for most samples, except for zinc and copper, which were detected at concentrations of 0.064 mg/L and 0.020 mg/L, respectively, in the residential site sample. These findings indicate potential contamination from anthropogenic activities in the residential area.

Overall, these results contribute to a better understanding of the water resources in the Garchuk area, emphasizing the need for effective management strategies to protect the environment and ensure the safety of public health. It is crucial to address the identified issues, such as oxygen depletion and organic pollution, to maintain the water quality in the region. Additionally, measures should be taken to monitor and mitigate heavy metal contamination to safeguard the groundwater resources. By implementing appropriate management practices and raising awareness among stakeholders, it is possible to improve water quality and preserve the well-being of the community.

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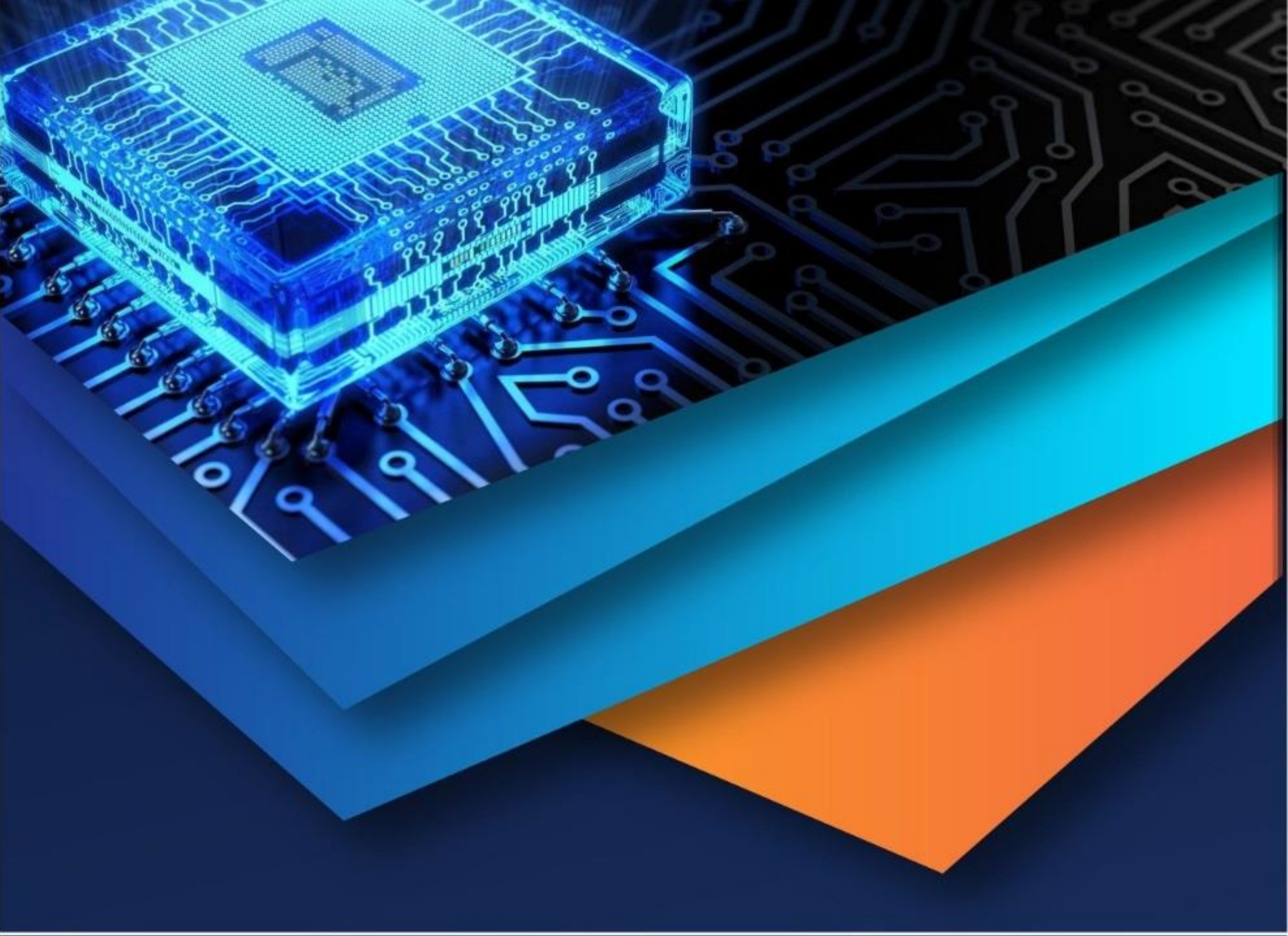

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