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An Assessment of Water Quality in Tirur River, Kerala, South India

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Abstract: ***This study was carried out to determine the Tirur River water quality based on the physicochemical and microbiological parameters, and its impacts on aquatic ecosystem. The water samples were collected from five stations along the river and water quality parameters were studied during October 2015 to March 2016. The study revealed that physiochemical and microbiological parameters of Tirur River fluctuated with season and location. Concentrations of many of the elements were higher than the desired limit as per BIS (Bureau of Indian Standards) and pollution has reduced the amount of dissolved oxygen in the Tirur River. This study demonstrated the poor microbiological quality of Tirur River and the studied four sites have high levels of E.coli. Construction of regulator cum bridge(RCB) at Koottayi negatively affected the quality of water due to the restriction of natural flushing action of the river and accumulation of pollutants. Results indicate that the water of Tirur River is highly contaminated except Ayyapanov (site near to origin), anthropogenic activities left it in the mouth of death.***
Key words: Tirur River, water quality parameters, dissolved oxygen, total coliforms, water quality deterioration

I. INTRODUCTION

Rivers are an important part of the earth's water cycle and the sculpting of the earth's topography as they carry huge quantities of water from the land to the sea. Rivers frequently constitute the main water resource for inland areas, for irrigation, drinking and industrial activities. River is being polluted by indiscriminate disposal of sewage, industrial waste and plethora of human activities, which affects its physicochemical characteristics and microbiological quality [1]. Water pollution is a serious problem as almost 70% of Indian surface water resources and a growing number of ground water reserves have been contaminated by biological, organic and inorganic pollutants[2]. The burden of reduced water quality is felt not just by the community in the immediate vicinity of its production, but by a continuum of downstream communities as well[3]. Availability of freshwater of adequate quantity and quality is a prerequisite for sustainable development. The river water resources in Kerala state are subjected to substantial stress due to changes in riverine ecology [4]. Tirur River, Malappuram district is navigable and forms part of west coast water transport system. The river now faces significant challenges for its survival [5]. The main objective of the study was the assessment of the water quality of the Tirur River and its impacts on aquatic ecosystem

II. EXPERIMENTAL

In both upstream and downstream areas, field surveys were conducted. Water samples collecting sites were selected on the basis this preliminary studies and its impact on ecosystem. An interaction with local people living in the surrounding of the sampling sites were also done and gathered information regarding agriculture, water availability, water quality and socio-economic status.
Drainage area of Tirur River was delineated and prepared drainage map with help of Kerala Landuse Board, Trissur, Kerala, India. Three replicates of water samples were collected from five stations along the Tirur River. The selected sites were Ayyapanov-S1 (near to origin), Kanathukadavu-S2, Thazhepalam-S3, Thalakadathoor-S4 and Koottayi-S5 (near to regulator cum bridge). The investigation was done during October 2015 to march 2016. The water quality parameters namely temperature, pH, conductivity, total hardness, nitrate, phosphate, dissolved oxygen, biochemical oxygen demand (BOD), total coliform and *E.coli* were analyzed as per standard methods [6].

III. RESULTS AND DISCUSSION

Tirur River originates from the hillocks of Athvanad village, Tirurtaluk in the Malappuram district of the Kerala state in south India and flourished with water from wetlands of the Malappuram district. Tirur Riverflows south-west to Thiruvnavaya and then north-west to Elamkulam where it turns south-west, joining the Bharathapuzha River which flows into the Arabian Sea (Fig. 1a). In the upper reaches, the river is known as the Vallilapuzha. The river has a length of 48km and drains an area of 117sq.km. The drain basin includes 14 grama panchayaths and 2 municipalities (Fig. 1b).The drainage pattern of the riveris generally dendritic. Analysis

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of the drainage characteristics of the basin reveals that river is fifth order stream (Fig. 1a). Canoli Canal, which passes through the Niramaruthur and Vettom GramaPanchayaths joins with Tirur River at Koottayi.

Fig. 2 summarises the physicochemical parameters from the five sampling stations along the Tirur River. The parameters showed seasonal fluctuations and the pollution was severe during summer (March) compared to the rainy season (October).Temperature of environment and river affects the physico-chemical parameters of water. The increase in water temperature leads to the speeding up of chemical reactions in water, reduces the solubility of gases and amplifies the taste and odours [7]. Temperature of Tirurriver water ranged from 28.5°C to 32.6°C. The pH range suitable for the existence of most biological life is quite narrow and critical, and is typically 6-9. The value of pH of the water varied from 6.2 to 8.01. pH range between 6.5 and 9.5 has been found to be suitable for fish production [8]. The pH values of all the sites during the sampling period were within the prescribed limits (6.5-8.5) as per BIS [9].

The conductivity values in the water samples ranged from 140 to 620 µmhos/cm. Electrical conductivity (EC) is a measure of the ions present in water, and therefore a surrogate for total dissolved solids (TDS). According to BIS standards, the desired limit of electrical conductivity (EC) of river water is 50 to1500 µmhos/cm. From the result of the present study, it is clear that EC of the water samples at various sites of Tirur River are in desired limit.

Total hardness in the river varied from 17mg/L to 850 mg/L. Total hardness of surface water varied according to seasons. The analysis revealed that the total hardness of water in four sites were exceeded the desirable limit during summer season (as per BIS, desirable limit is 200mg/L and permissible limit is 600mg/L). Hardness is governed by the amount of Ca^{2+} and Mg^{2+} salts largely combined with bicarbonate, carbonate, sulphate and chloride. The increase in hardness may be due to the domestic activities like washing clothes, animals, vehicles etc. done at the river site.

The value of nitrate ranged from 0.03 mg/L to 12.2 mg/L which is below the permissible limit of BIS (45 mg/L). Nitrate is one of the critical nutrients for the growth of algae and help in accelerating eutrophication. The most important source of nitrate is biological oxidation of organic nitrogenous substances, which come in through sewage and agriculture fields. The phosphate ranged from 0 mg/L to 0.04 mg/L with an average of 0.016 mg/L. This value is within the standard limit. According to the criteria of phosphate by Lee et al., [10], the river falls under mesotrophic condition.

Dissolved oxygen concentration ranged from 1.3 to 6.5 mg/L in the study. The highest DO concentration was recorded in monsoon season (6.5 mg/L) and lowest D.O was recorded during summer season in all the sites. The low levels of DO concentration in the fresh water aquatic systems is an indication of high levels of organic pollution [11]. The introduction of oxygen demanding materials, mainly organic, into the river causes depletion of the dissolve oxygen. During summer, dissolved oxygen observed was below 2.5mg/L in the selected four sites. From this it is clear that Tirur River water is highly unfit for the survival of aquatic life. Dissolved oxygen is one of the most important factors for aquatic life and most species become distressed when DO levels drop 4 to 2 mg/L [12]. On June 2012, thousands of dead and dying fishes were found in a stretch of more than 12 km from Mangalam to Thalakadathoor area along the Tirur River.

.Decreased DO levels may also be indicative of too many bacteria and an excess amount of biological oxygen demand. BOD ranges from 0.2-11mg/l. The highest value 11 mg/L is not meeting the water quality criteria for drinking and bathing with respect to BOD (as per BIS BOD 5 days 20°C for drinking is 2mg/L or less and bathing is 3mg/L or less). The low value of BOD at Ayyapanov area clearly indicates the low level of biodegradable material. High BOD and COD are noticed along with high fish mortality by interfering with respiratory metabolism [13].

Total Coliform value ranges from 0.01 to 6.8 x 10^3 MPN/100ml and E.colivalue ranges from 0 to 2.8 x10^3 MPN/100ml (Fig. 3).*E.coli* in fresh water can indicate the presence of pathogens from animal or human feces. The higher value of coliform bacteria and organic pollution is mainly due to discharge of septic waste and wastewater directly through small drains into the river. Total Coliform andE.colicount were so high making the water not suitable for drinking, domestic and other recreational purposes. Constructing regulator cum bridge at Koottayi is effective in control of salinity intrusion into the upstream. But, the natural flushing action of river is lost due to the closing of shutters and water became stagnant. Due to this, total coliforms and E.colicounts of water are much higher than the desired values and enhanced the pollution. In overall analysis, the River is highly polluted. However, the site Ayyapanov is relatively clean and complying with the criteria (BIS 2012). The seasonal variation in water quality parameters were statistically significant ($P<0.05$) especially dissolved oxygen and E.coli.

Due to changes in the quantity and quality of water, some environmental disasters are causing stress and hardships in a river basin in around the world [14]. Survey conducted in the study area revealed that the main problem faced by the people is poor quality of water as a result of pollution. The dumping of garbage and solid waste (including poultry waste), direct sewage discharge (from houses, hotels and markets) and discharge from small industries are the main reason for Tirur river pollution. Another major

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contributor to pollution of the Tirur River is Canoli canal which joins at Koottayi. Almost all species of fish found in the river were affected including different kinds of catfish, mullets, barbs, and pearl spot. A large number of prawns were also found affected due to pollution and RCB. Koottayi estuary near RCB was the main breeding places fishes and prawns. The survey reveals that aquatic flora and fauna in and alongside of the river has gone up by 70% during the past three decades, thereby affected the health of this socio - economically and ecologically important river ecosystem.The water quality of a system depends on the terrain through which it flows. Transformation of paddy lands for various purposes, and filling up of ponds, natural streams and canals in between the dry lands also affected water quality and the flow of Tirur River. Constructed encroachments of urbanization (especially in and around Tirurtown) and encroachments by villagers within river corridors and floodplains are frequent in the river bank. The channel of Tirur River is shrinking and vacated land is getting available for human settlements, which are mostly unplanned, and therefore, obstructing the original path of rivers leading to high risk. Encroachment increases impervious cover adjacent to rivers and thereby increasing the rate and volume of runoff, loading of sediment and other pollutants, and temperature of the receiving water [15].

IV. CONCLUSION

The water quality of the Tirur River is relatively better during rainy season due to higher river flow compared to the summer season. Results of the physicochemical parameters indicated that water in Tirur River is highly contaminated (except Ayyapanov), and not safe for drinking and it is also unhealthy for the aquatic life. The microbiological examination of river water in respect of Total Coliform/100 ml at four sampled sites has confirmed that the river water is unfit for direct consumption, bathing or any other domestic use. If proper measures are taken for the treatment of sewage before discharge and restrictions are made out on various anthropogenic activities, the river would remain healthy in the long run. A coordinated effort of government agencies, non-government organizations, local bodies and public is needed to restore the water quality and rejuvenate the river ecosystem.

V. ACKNOWLEDGEMENT

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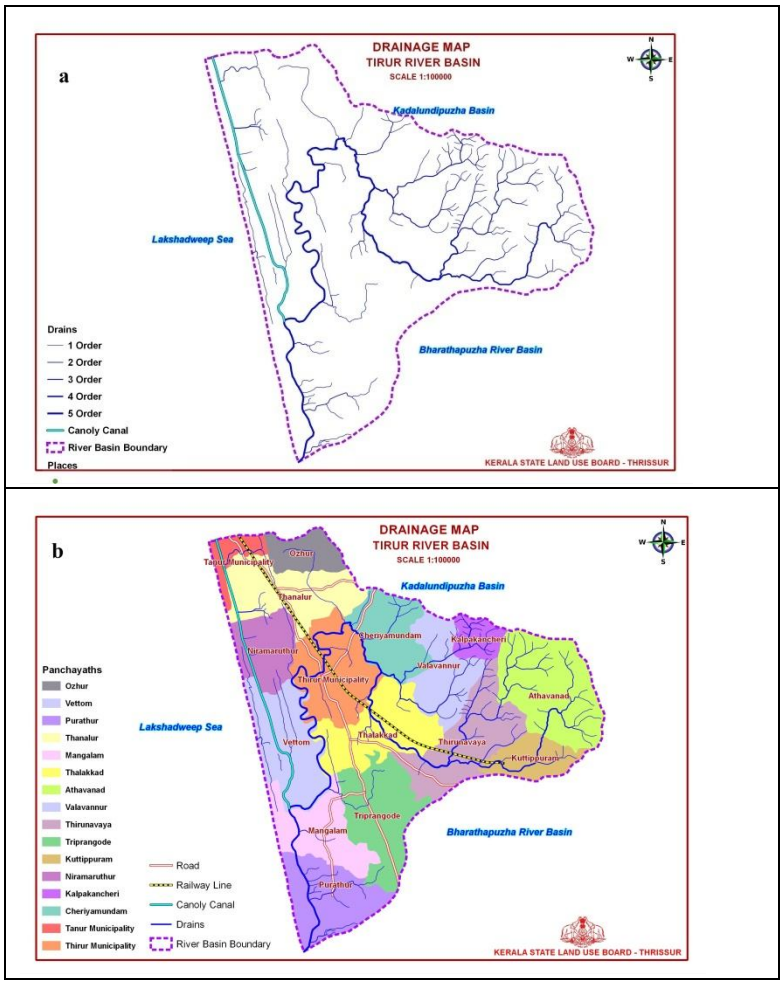
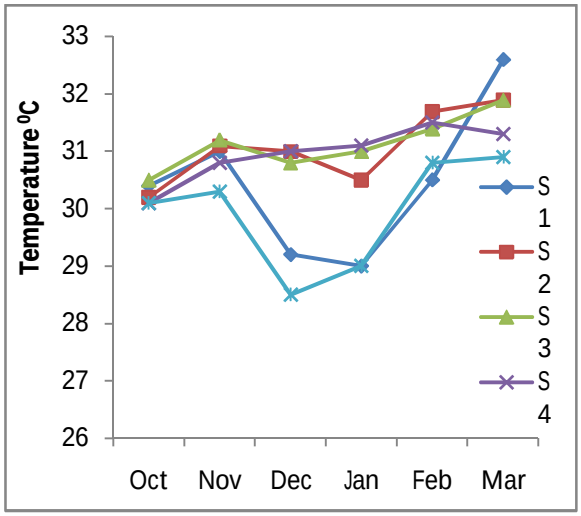
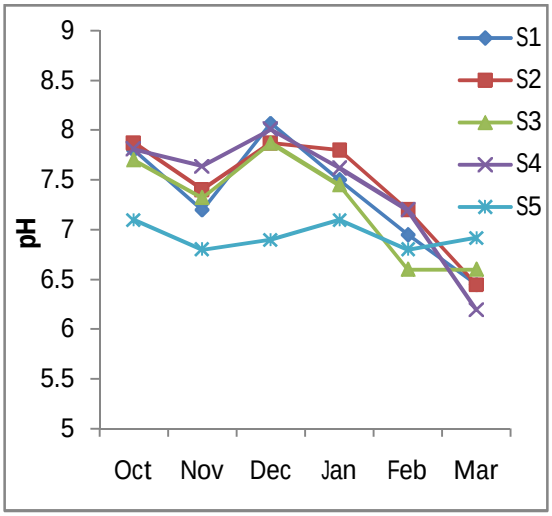


Fig. 1a & b. Drainage basin of Tirur River





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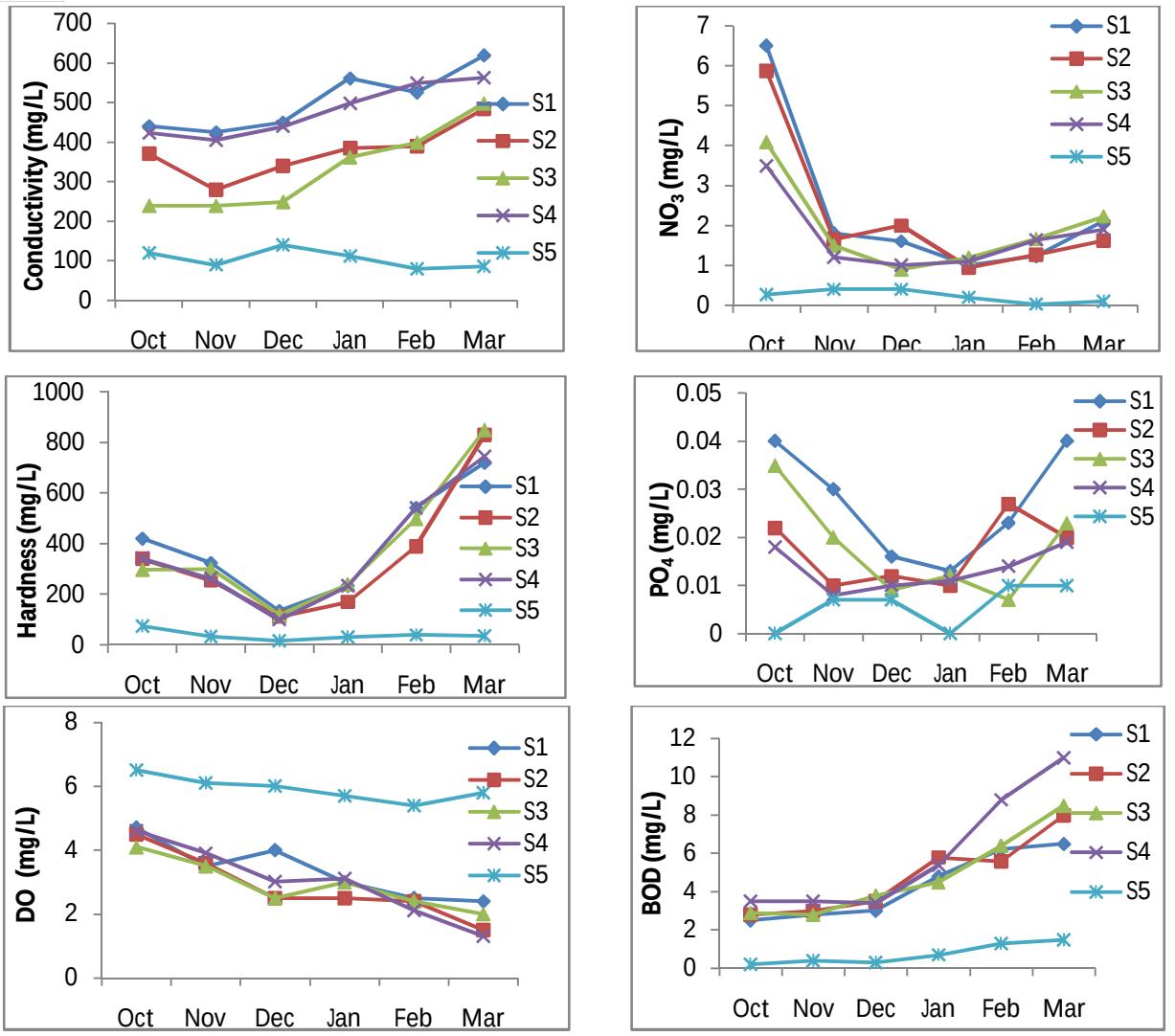

Fig. 2 Physicochemical characteristics of water of Tirur river (October 2015 to march 2016)

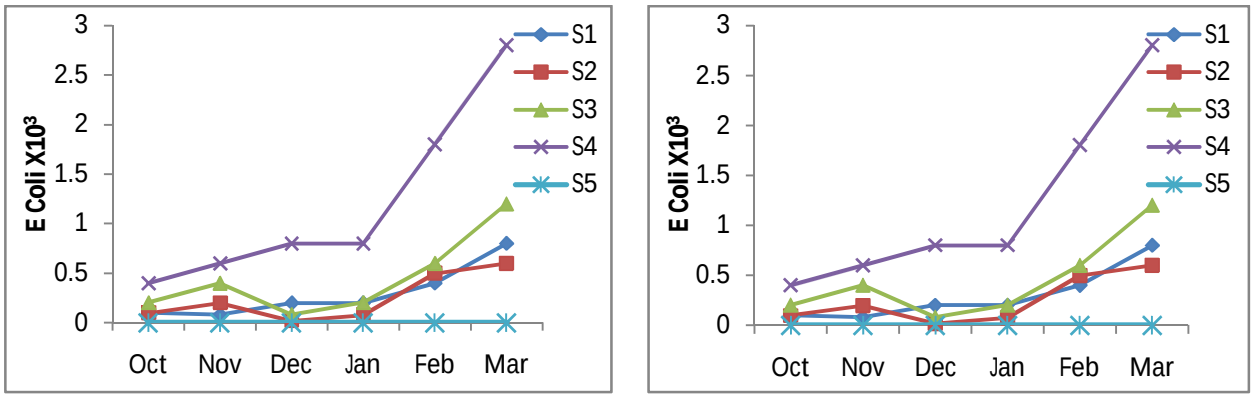

Fig. 3 Microbiological analysis of water of Tirur river (October 2015 to march 2016)

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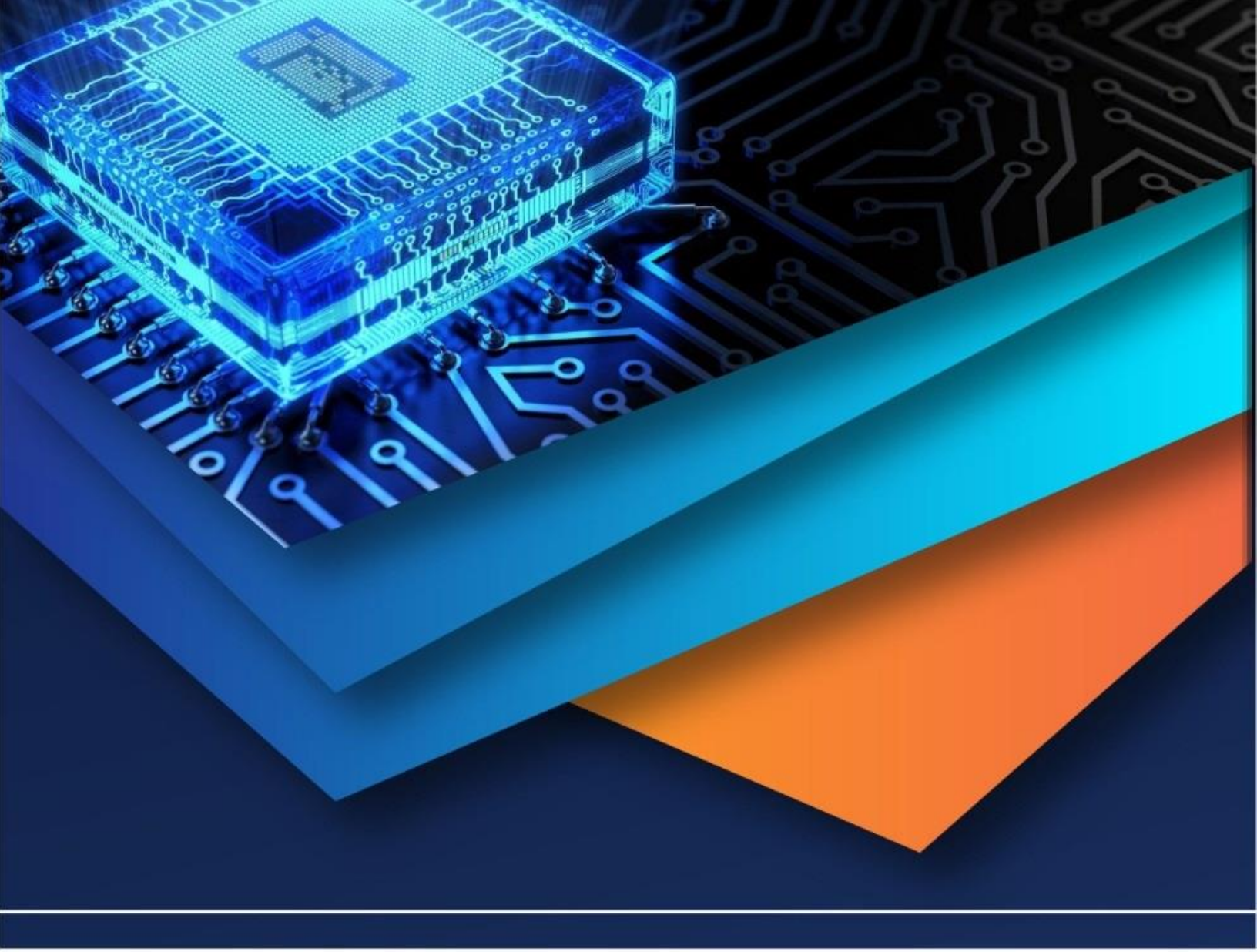

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