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Power Quality Improvement by UPQC with Wind Turbine System using ANN

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Abstract: ***Power quality (PQ) problem can be defined as the deviations of the voltage and current from the nominal sine wave. PQ problems generally concern with voltage sags, swells, interruptions and harmonic currents. This work presents ANN controller based UPQC system under wind turbine system for reducing THD value in PV system. It also provides the concept of operating wind turbine with UPQC. The Unified Power Quality Conditioner (UPQC) is a custom power device, which diminishes voltage and current related power quality issues. It uses a PWM control for firing the circuit and provides six clock pulses for operating the IGBTs circuit. The system performance for current harmonics, voltage harmonics, voltage sag and voltage swell are evaluated. In this, it provides reliability up to power factor value of 0.9.***
Keywords: UPQC, Power Quality, ANN Controller, Power Factor, Voltage Sag, Swell etc.

I. INTRODUCTION

The modern power framework is an complex system that comprises of various generators, transmission lines, assortment of loads and transformers. With the expansion of nonlinear loads in the electric power dispersion arranges, an issue of Power Quality (PQ) is being experienced. Any sort of voltage or current deviation from the perfect structure causes power quality trouble influences. An unexpected change in load because of trouble influence or flaw offers ascend to an adjustment in voltage or current separately. The voltage aggravations that are made at the power system will possibly influence the clients. The wellness of electrical capacity to buyer devices depict about the electric power that drives an electrical load and the capacity to work appropriately.

A inconsistent power appropriation may prompt the breaking down of the electrical device that at last prompts the devastation of the device. Power is basically the progression of vitality and the current demanded by a load is for the most part wild. For the correct working of sensitive hardware, fueling and establishing of that specific gear is essential. A gigantic use of electric segments in ventures and living arrangements followed by the expanded utilization of nonlinear loads cause serious issues in electrical frameworks prompting a sudden increment in voltage, flow and harmonics issues. Voltage lists, voltage swells, homeless people, harmonics distortion, flashes, voltage lopsided characteristics, interferences and blackouts are a portion of the PQ issues. Making investigation on these issues is by all accounts harder in light of the fact that the exchanging activity inside an office might be connected here and there to control frameworks that are miles separate. So, the producers of electrical hardware's and clients have more prominent mindfulness towards these issues [1]. PQ is basically worried about the issues like holding voltage that is fixed PCC for various appropriation levels independent of the voltage vacillations, keeping up a power factor that is nearer to solidarity for the power drawn from the gracefully Various sorts of PQ trouble influences in power framework. A three-stage, four wire circulation framework encounters helpless voltage guideline, high receptive power necessity, harmonics current load, load unbalancing, varying current, voltage issues, voltage sag and voltage swells as its most significant power quality issues. Low power factor, low productivity and overheating of transformers are a portion of the elements that outcome because of the PQ issues. Further, the current in a three-stage, four wire dispersion framework that cause overheating of the impartial system with its principle and high harmonics parts stream in overabundance, at that point the general load on the framework is hard to adjust.

The load associated with a system would run acceptably with better proficiency if the PQ of the system holds great. The establishment running cost will be high if the load associated with a system bomb because of poor PQ. Keeping up the power quality inside average levels is consistently a test. Conveying poor PQ will prompt an ascent in power misfortune, unordinary and undesirable conduct of electrical utensils, impedance with close by correspondence lines, etc. What's more, the broad utilization of intensity electronic based frameworks with their voltage and current harmonics created with high receptive current likewise influences the power framework. The dynamic power, responsive power, variety of voltage and flow, glint, harmonics, and electrical conduct of exchanging activity are the key factors that are to be considered during power quality estimation. The affectability to PQ issues is getting more basic in territories like consistent procedure ventures and data innovation administrations.

The remainder of paper is requested as follows. In segment II, it provides the concept of UPQC for power quality improvement. In Section III, It characterizes the proposed work related to system. Results are presented in Section IV. At last, conclusion is clarified in Section V.

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II. UPQC FOR POWER QUALITY IMPROVEMENT

The PQ is non linear in nature and presence of different faults in power system. Furthermore, the electronic devices and equipments based on new computer technology require high levels of PQ. Due to small change in PQ, this type of devices is sensitive in nature. A small change in time interval on PQ can cause great losses. The expanded stacking of intensity frameworks in mix with deregulation of intensity industry animates power stream control to send power with less expense. The free and reasonable exchange of power is as a rule enormously constrained in the open power showcase because of the issues in the serious power advertise like the clog the executives, improvement of security and existing exchange ability of the framework and transmission evaluating [3].

For holding the security of sensitive loads and for offering expanded power quality, the UPQC that is an expansion of the UPFC idea at the dispersion level can be utilized. An UPQC does both the jobs of D-STATCOM and DVR. The UPQC has two VSCs, one of which is connected in arrangement with a circulation feeder and the other associated with a similar feeder in a shunt way. A typical DC vitality stockpiling capacitor supplies the dc-connections of both VSCs that are associated through a typical transport. An UPFC do arrangement and shunt pay all the while in a power framework like the UPQC. Association of two VSCs to two unique feeders in a circulation framework is plausible these days.

The primary reason for creating UPQC is to dispose of the difficulties that are related with the working of urgent load in power framework and to remunerate gracefully voltage gleam/awkwardness, responsive power, negative-succession current, and sounds. The UPQC can improve the nature of intensity delivered at its establishment spot on power dispersion frameworks or modern power frameworks. Henceforth, the UPQC can presumably take care of issues associated with enormous capacitive loads that show more noteworthy reaction to gracefully voltage flash or lopsidedness. The UPQC, along these lines, is relied upon to be one of the most impressive answers for huge limit loads delicate to gracefully voltage glint/awkwardness. The achievement requires the recognition of voltage and current as the pivotal advance and different calculations like immediate responsive power hypothesis, Fourier change and versatile calculations. Of those previously mentioned calculations, the calculation that is of broad use is the momentary receptive power hypothesis-based location calculations.

Despite the fact that the losses and harmonics are decreased with the assistance of UPQC, there are issues with the working of half and half sifting as the channel attributes depend on load impedance and gracefully harmonics. The structure of PI and PID regulators require a precise numerical model and furthermore, they quit working under boundary changes and load trouble influences. Henceforth various endeavors are made to develop elective novel procedures to beat the faults of the current regulators and to support the enterprises and assembling segments in confronting the troubles related with controlling.

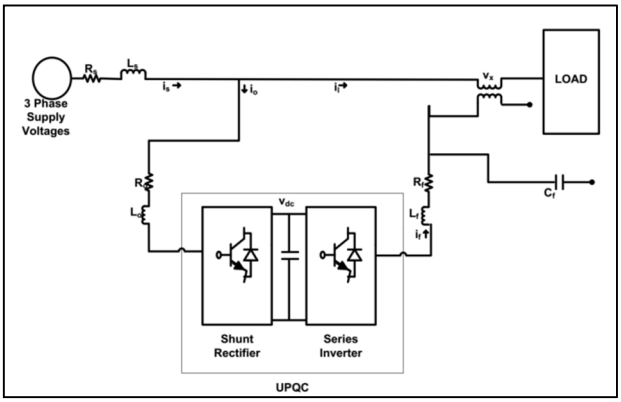

Fig 1: Block Diagram of UPQC [3]

The UPQC contains two APFs associated consecutive with a typical dc interface between them. A square chart of the UPQC is appeared in Fig. 1. The arrangement APF (supposed in light of the fact that it is associated in arrangement) is a three-stage VSI. The two converters are beat width tweaked (PMW) controlled. The PWM conspire is utilized to accomplish the accompanying target: For the arrangement converter, to control the voltage at load and for the shunt inverter, to flexibly responsive power, manage the gracefully power factor and keep up the dc connect voltage steady at its appraised esteem. Fundamentally, power electronic converters are a course of action of exchanging devices and a decided exchanging technique or arrangement inside the requirements of circuit design to accomplish the goal of intensity change. an acknowledgment of a three-stage inverter (as shown in Fig 1). It involves a plan of six exchanging devices which are controlled to give a variable harmonics voltage source [4].

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III. PROPOSED WORK

In this work, UPQC with wind turbine system is designed. The generation of wind is based on topology of speed. UPQC has a good stable circuit that can attach any type of major load like wind turbine easily. This wind energy system converts kinetic energy into rotational motion and then speed matching is performed in the system. The turbine K.E is converted into mechanical energy and shaft of turbine is joined with shaft of generator. Then generated power is transmitted into system.

In economic and innovation advancement, Electricity flexibly assumes a noteworthy job all through the world. Economic development of nation relies on quality power supplies. The principle point of framework is to give appropriate sinusoidal yield of steady voltage and current with harmonics of 50 Hz in Indian framework and THD esteem must be under 5% as per Indian norm. The expanded utilization of computerized gear, as flexible speed drives, programmable rationale regulators, exchanging power supplies, bend heaters, electronic fluorescent light stabilizer, robotized creation lines are unmistakably more defenceless against trouble influences. It is anyway not just resolute quality that the customers need nowadays, quality also is significant for them. With the deregulation of the electric power vitality advertise, the mindfulness in regards to the nature of intensity is expanding step by step among clients. PQ is an issue that is getting progressively critical to power buyers at all degrees of use. Our capacity framework contains numerous non-straight loads like electric curve heaters, power electronic convertors and so forth which present flow and voltage harmonics. In any case, PQ aggravations, for example, drops, swells, flash, sounds, voltage irregularity and so on., make a ton of issues in accomplishing a dependable and quality power flexibly [9]. UPQC comprise of consolidated arrangement dynamic power channel that repays voltage harmonics of the power flexibly, and shunt dynamic power channel that remunerates harmonics flows of a nonlinear load. This double usefulness makes the UPQC as one of the most appropriate devices that could take care of the issues of the two purchasers just as of utility. The UPQC, in this way, is normal as one of the most remarkable answers for huge limit sensitive loads to voltage gleam/unevenness.

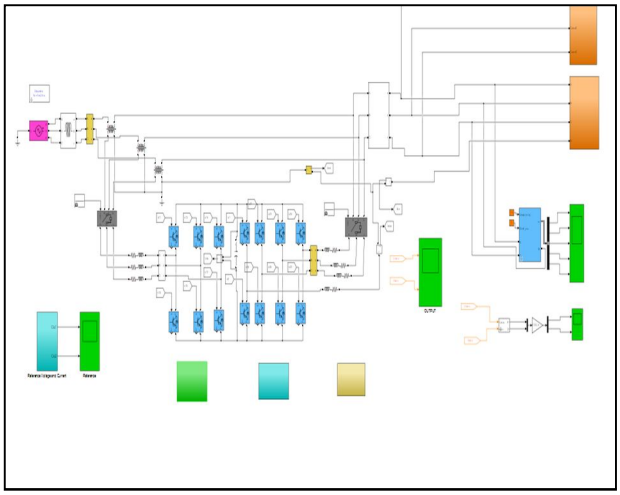

Fig. 2: Proposed Simulink Model

A. Proposed Simulation Model

The SIMULINK model of test framework is appeared in Fig 2. The framework contains two regulators, one is associated in arrangement and other is associated in equal. It likewise contains transformers and channel banks for alluring yield. The framework is tried under various burden conditions. A variable burden is utilized to give consistent current yield. Here, framework utilizes three stage input programmable source. This framework is most appropriate under a few PQ issues like voltage list, swell, sounds and interference and so forth. The arrangement regulator is intended to infuse a powerfully controlled voltage in extent and stage into the dispersion line by means of a coupling transformer to address load voltage. This is known as Dynamic Voltage Regulator (DVR) which is prevalently utilized as an arrangement associated custom force gadget. It utilizes ANN regulator in shunt regulator to repay current level. The motivation behind the Shunt Controller is to remunerate current unbalance, current music and burden receptive force request took care of to the flexibly. The coupling of shunt regulator is three stage, in corresponding to network and burden. It fills in as current sources, associated in corresponding with the nonlinear burden, producing symphonies flows the heap requires. This is same as the prominently realized shunt associated custom force gadget, D-STATCOM. UPQC is a blend of DVR and D-STATCOM.

B. Components of UPQC

The primary segments of an UPQC are arrangement and shunt power converters, DC capacitor, LC channels, and arrangement and shunt transformers.

1) *Series Converter*: It is a voltage-source converter associated in arrangement with the AC line and goes about as a voltage source to alleviate voltage bends. It is utilized to dispose of flexibly voltage glints or irregularity from the heap terminal voltage and powers the shunt branch to ingest current sounds created by the nonlinear burden. Control of the arrangement converter yield voltage is typically performed utilizing sinusoidal heartbeat width balance (SPWM).

2) *Shunt Converter*: It is a voltage-source converter associated in shunt with a similar AC line and goes about as a current source to drop current mutilations, remunerate receptive current of the heap, and improve the force factor. This framework utilizes ANN regulator in shunt framework to remunerate current qualities. It additionally plays out the DC-interface voltage guideline, bringing about a noteworthy decrease of the DC capacitor rating. It uses ANN controller in shunt controller to reimburse current level. The inspiration driving the Shunt Controller is to compensate current unbalance, current music and weight open power demand dealt with to the deftly. The coupling of shunt controller is three phase, in relating to network and weight. It fills in as current sources, related in comparing with the nonlinear weight, creating symphonious streams the load requires.

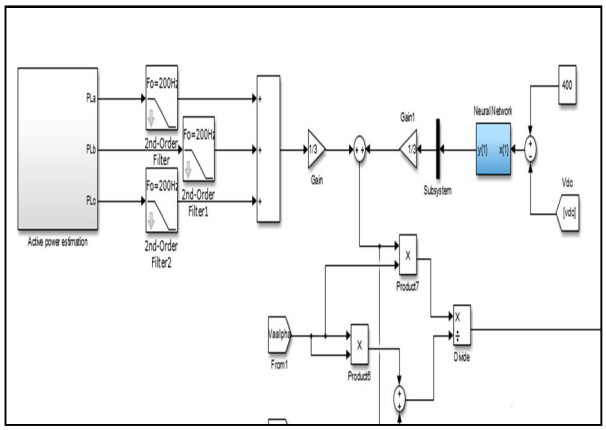

Fig 3: Control Strategy using ANN

IV. RESULTS & DISCUSSION

In this segment, the after effects of the Simulation model of UPQC are introduced. UPQC is a custom force gadget that can deal with PQ issues viably. The boundaries of the VSI should be structured cautiously for better following execution. The significant boundaries that should be mulled over while planning ordinary VSI are V, Csh, Lsh ,Lse, Cse and recurrence and are recorded in Table 1.

Table 1: UPQC System Parameters

System Quantities	Values
Source	3-Phase,25kV, 50Hz
Inverter Parameters	IGBT based, 3-arm, 6-Pulse
Input L Load	L=0.1 mH
DC Filter	C=5 mH
Power Factor	0.9
Controller	ANN Based

To check the effectiveness of control structure with down to earth limits, a MATLAB/SIMULINK based modernized entertainment is finished. The display of UPQC under such condition with different conditions, for instance, voltage sag and swell compensation are attempted. Fig 4 shows the three phase voltage waveforms as data voltage.

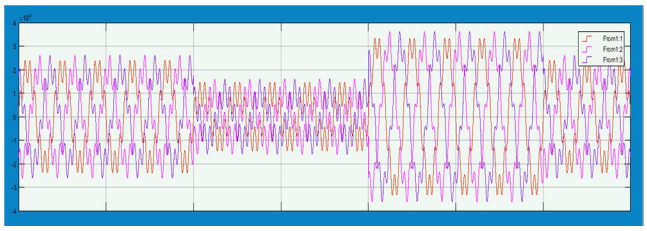

Fig 4: Input Voltage with Voltage Sag, Swell & 3rd Order Harmonics

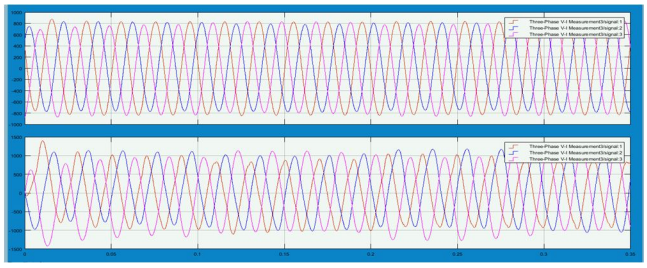

Fig 5: Output Load Voltage with Harmonics by UPQC-ANN

The yield profile in Fig. 5 shows the UPQC is suitably keeping up the voltage at load at needed consistent level regardless, during the swell on the system with the ultimate objective that the piles are not affected by any voltage assortment. By the day's end, the extra power in view of the voltage swell condition is dealt with back to the source by taking decreased critical source current. The proposed UPQC kept up the voltage at load freed from growing and at the perfect level. Full scale Harmonic Distortion (THD) is the dedication of all the harmonics repeat streams to the head. Table 2 shows the introduction assessment of system with UPQC and UPQC-ANN structure the extent that THD and result shows that proposed structure shows better improvement in THD when stood out from genuine structure due to nature of ANN controller.

This system is connected with Wind Turbine after getting output from UPQC System with ANN Controller is presented in this work. The output in terms of Voltage and Current helps to generate active and reactive power of system as shown in fig 6. The response parameters are shown in terms of stator voltage and current, torque response etc. It gets DC pulse output at stator of wind. Table 3 shows the performance comparison of proposed system with actual results and shows better improvement in THD value. The generation of wind is based on topology of speed. UPQC has a good stable circuit that can attach any type of major load like wind turbine easily. This wind energy system converts kinetic energy into rotational motion and then speed matching is performed in the system.

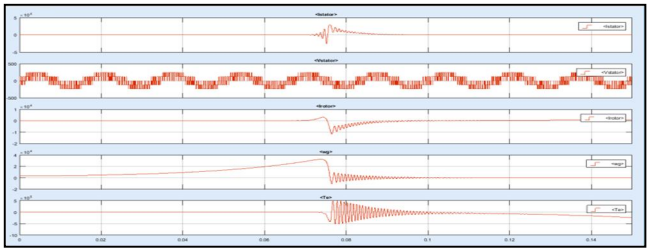

Fig 6: Response Parameters of Wind Turbine with UPQC System

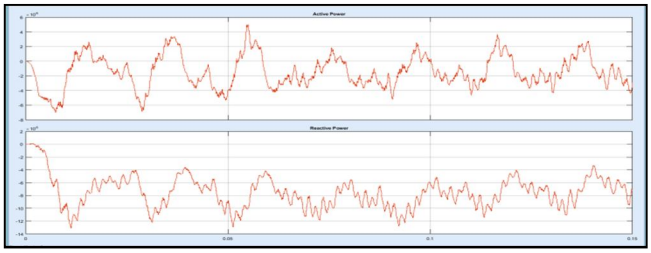

Fig 7: Power Response of Wind Turbine with UPQC System

Table 2: Performance Comparison of System

Parameter	UPQC [22]	UPQC-ANN
THD (%)	3.06	2.63

V. CONCLUSIONS

In this work, the main concern to improve power quality in system by the use of UPQC model with wind turbine system. The primary point of this proposal is to grow new model for UPQC with ANN regulator to decrease impact on PV framework. So as to shield basic burdens from more voltage sounds, UPQC is appropriate and palatable. Because of its dependability it was embraced as the ideal answer for the pay of voltage and current. This work researched the advancement of UPQC for power quality improvement and usage of an adaptable control procedure to upgrade the presentation of UPQC. This system is beneficial for handling voltage sag, swell and harmonic problems in three phase system due to presence of heavy variable load under 0.9 power factor. The result shows that proposed system shows better improvement in THD as compared to actual system due to presence of ANN controller. The destinations have been effectively acknowledged through programming execution in MATLAB/SIMULINK.

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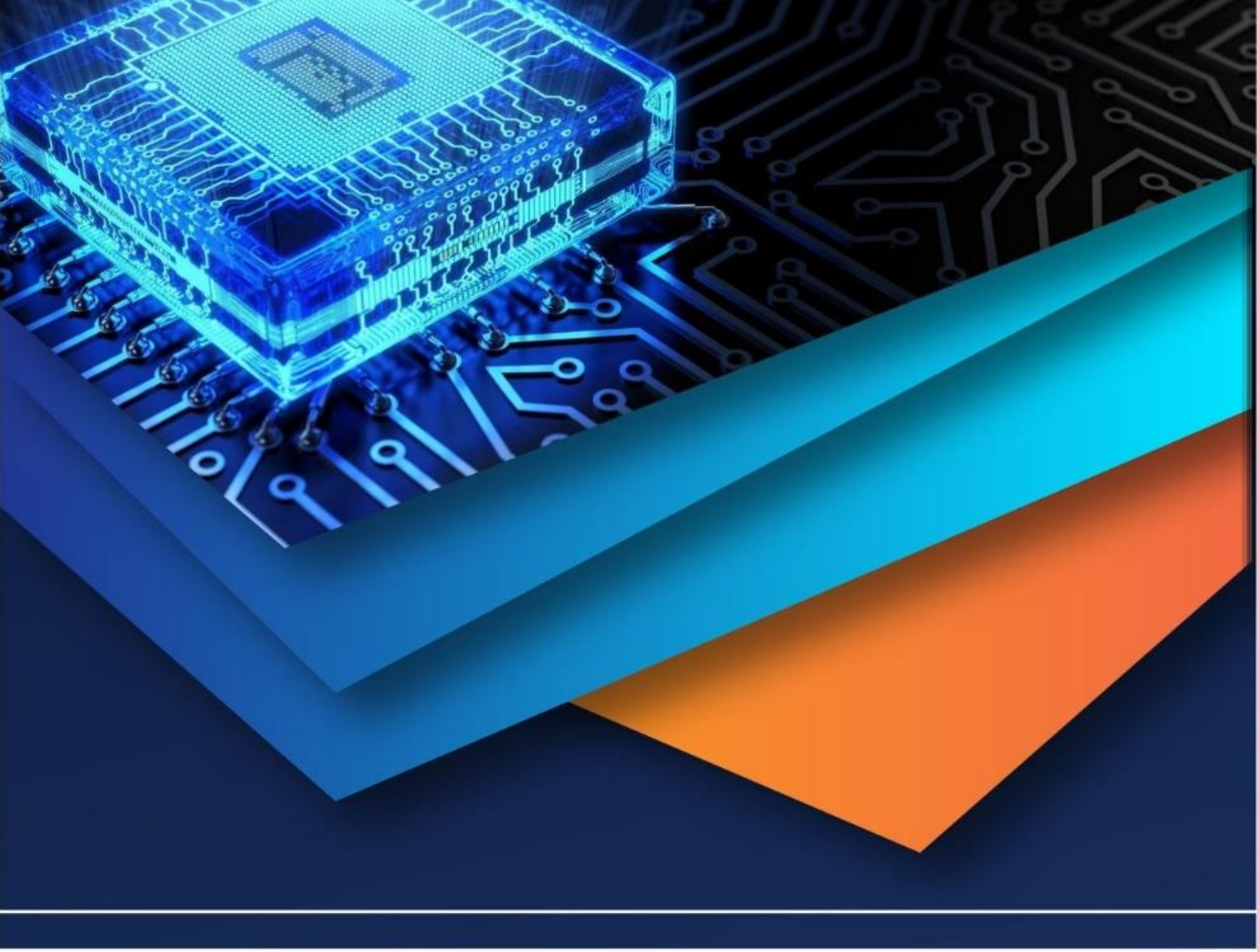

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