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Modelling Simulation and Performance Assessment of Multi objective Economic and Emission Dispatch Problem Using Improved Particle Swarm Optimization

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Abstract: In the previous decade, numerous endeavors have been made to tackle the ELD issue, and different sorts of requirements or targets have been joined through different scientific arranging and optimization systems. Customary techniques incorporate the Newton-Raphson strategy, the Lambda iterative technique, the Base Point and Partitionation Factor strategies, the Gradient strategy, and so forth. Be that as it may, these exemplary scheduling algorithms require gradual cost bends to be monotonically expanding or fragment by-section direct. Considering the profoundly nonlinear nature of the component requires a very strong algorithm to abstain from adhering to neighborhood ideal. Since the issue is non-direct, procedures dependent on established analytics can't take care of these kinds of issues. The objective of the research paper is to design and simulate quantum computing based modified particle swarm optimization for multi objective emission and economic dispatch problem. The algorithm has been tested on multiple test systems with valve point loading cost function as well. Results have been compared with contemporary research and found to be efficient in comparative assessment on same test system.
Keywords: Economic Load Dispatch (ELD),Genetic algorithms (GA), Evolutionary strategies (ES), Evolutionary programming (EP), Particle swarm optimization (PSO)

I. INTRODUCTION

We can characterize economic load scheduling (ELD) as the way toward allocating load levels to generator sets with the goal that framework loads are completely and economically conveyed. In interconnected power frameworks, costs must be limited. The creation dimension of every generator set is characterized by the economic load conveyance, so the complete expense of producing and transmitting power is the most unrealistic for a given load plan. The motivation behind economic load scheduling is to limit the absolute expense of creating power. The circumstance turns out to be progressively confused when service organizations endeavor to address transmission line misfortunes and regular variances related with hydropower plants. There are various traditional methods that can be utilized to address economic load circulation issues, for example, Lambda emphasess, Newton-Raphson and Lagrangian multipliers. The whole interconnection organize is constrained by the load dispatch focus. The MW power age for every lattice is relegated by the load dispatch focus, contingent upon the essential MW interest for that region. The activity of the load control focus is to keep up the power trade between various areas and framework frequencies at the required qualities. There are numerous options in contrast to scheduling age. In interconnected power frameworks, the essential objective is to locate the real and responsive power anticipates every individual power plant in a way that limits working expenses. This is known as the "economic load scheduling" (ELD) issue. The target work is likewise called the cost work. These target capacities can bring economic costs, framework security or different objectives. The misfortune factor is known as the B factor. The fundamental motivation behind the economic load scheduling issue is to limit the all out expense of producing real power.

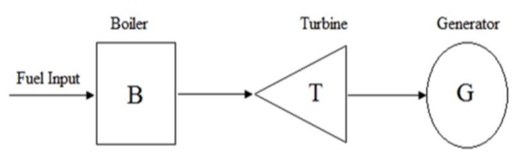

Figure 1.1 Simple Model of Fossil Plant

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Figure 1.1 shows a simple model of the purpose of fossil plant scheduling. The cost is usually approximated by one or more secondary segments. The operating costs of the plant are shown in Figure 3.2. Therefore, the fuel cost curve in active power generation is in the form of a quadratic curve, as follows:

$$F(P_{gi}) = a_i P_{gi}^2 + b_i P_{gi} + c_i Rs/hr \quad (1.1)$$

Wherea_i, b_i, c_i is the cost factor of the i-th unitF (P_{gi}) is the total cost of generationP_{gi} is the generation of the i-generation plant

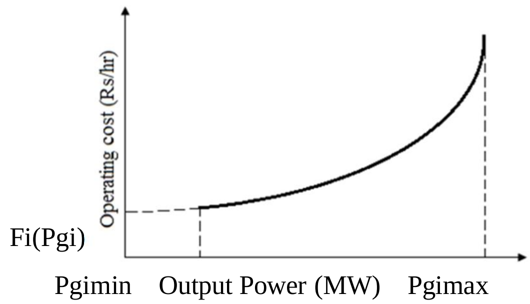

Figure 1.2 Operating Cost of Fossil Fired Plant

The fuel cost curve has many discontinuities,these occur when the output power is extended by using additional boilers, steam condensers, or other equipment. The is the minimum loading limit below which the operating device is uneconomical (or technically not feasible) and is the maximum output limit due to its rating

II. COMBINED ECONOMIC EMISSION DISPATCH

The function of fuel cost is simulated and approximated as a Cubic curve, whose total expression ($ / h) is for a period of time T and many generators N are given by:

$minF_T = \sum_{i=1}^{n} F_i(P_i)$ The economic dispatch problem can be defined mathematically as an objective with two constraints:

$$F_{ci}(P_i) = a_i P_i^3 + b_i P_i^3 + c_i P_i + d_i$$

Subject to the two constraints:

$$\sum_{i=1}^{N} P_i = D + L$$

$$P_{imin} \le P_i \le P_{imax}$$

Where P_i: power output (MW) of the i-th generator; F_T: Total fuel cost ($ / h); F_i (P_i): fuel cost per unit i ($ / h); D: Total demand (MW); L: transmission loss (MW);P_{imin}, P_{imax} large power limit of unit i (MW); and N: totalthe number of service units. Toxic gas released by thermal unitsBurning fossil fuel sources such as sulfur dioxide, nitrogen oxides and carbon dioxideCan contribute to minimizing the world aloneEmissions pass:

$$E_{SO2i}(P_i) = a_{SO2i} P_i^3 + b_{SO2i} P_i^2 + c_{SO2i} P_i + d_{SO2i}$$

$$E_{NOxi}(P_i) = a_{NOxi} P_i^3 + b_{NOxi} P_i^2 + c_{NOxi} P_i + d_{NOxi}$$

$$E_{CO2i}(P_i) = a_{CO2i} P_i^3 + b_{CO2i} P_i^2 + c_{CO2i} P_i + d_{CO2i}$$

In this work, we integrated the price penalty factor hi (maximum fuel cost / maximum emissions per gas) Emission equation $[F_{Ti}(P_i) = F_{Ci}(P_i) + h_{SO2i}E_{SO2i}(P_i) + \cdots h_{NOxi}E_{NOxi}(P_i) + h_{CO2i}E_{CO2i}(P_i)$

Where h_{SO2}, h_{NOx} and h_{CO2} are price penalties SO_2, NO_x and CO_2 are mixed with emissions Cost and normal fuel costs.

$$h_{SO2i} = \frac{F_{Ci}(P_{Maxi})}{E_{SO2i}(P_{MAXi})}$$

$$h_{NOxi} = \frac{F_{Ci}(P_{MAXi})}{E_{NOxi}(P_{MAXi})}$$

$h_{CO2i} = \frac{F_{Ci}(P_{MAXi})}{E_{CO2i}(P_{MAXi})}$ Comprehensive economic emission scheduling problem is a problem Combination of economic load scheduling and emissions Dispatch problems. In this paper, the cubic criterion function is Use CEED instead of quadratic function to represent CEED problem. Cube standard functions have been found more effectively resists nonlinearity of actual power system. Economic scheduling problems can defined as:

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$F(P) = \sum_{i=1}^{n} a_i P_i^3 + b_i P_i^2 + c_i P_i + d_i$ Where F(P_i) is the power generation cost of the generator set ($/ hour) output power is P_i; a_i, b_i, c_i and d_i are costs Generate the coefficient i of the unit. Emission scheduling issues can also be defined as cubes Standard functions with four transmit coefficients as:

$$E(P) = \sum_{i=1}^{n} e_i P_i^3 + f_i P_i^2 + g_i P_i + h_i$$

Where E (P_i) is the emission (in kilograms per hour) and Pi is the power Generated by unit i, and e_i, f_i, g_i and hi are transmitted coefficient. Minimize the goal of generating electricity costs Pollutant emissions can be converted into a single Use the target of the price penalty factor. Maximum/maximum fine Factors in this study were considered to address CEED issues. The CEED problem with the maximum/maximum penalty factor can be described as

$OF = F_T = \sum_{i=1}^{n} F(P_i) + \sum_{i=1}^{n} h_{iMAX/MIN} E(P_i)$ Where OF represents the objective function (CEED) and FT refers to Total cost and $h_{imax/min}$ are maximum/maximum penalty factors Generator set can define maximum/maximum penalty factor Such as

$$h_{imax/min} = \sum_{i=1}^{n} F(P_{imax}) / \sum_{i=1}^{n} E(P_{imax})$$

Where $P_{i,\,max}$ refers to the maximum power (in MW) can be generated by the generating unit i. The goal of this paper is to minimize power generation costs. And the emission of pollutant gases, i.e. the total cost Meet all other constraints. In the power generation system, need to have many equal and unequal constraints considered to optimize the actual situation system. Power balance and generator limit constraints the two most important constraints are considered here jobs. The total output power (megawatts) must be met Total load demand (in megawatts) Therefore, the total output power must Equal to the sum of total load demand and total load Power loss (MW). It can be defined as

$$P = \sum_{i-1}^{n} P_i = P_D + P_L$$

Where P_i, P_D and P_L are total generated power, total load demand and total loss, respectively.Each power generation unit in the power generation system has its upper and lower limits. Generate unit output Must be within this limit to work properly. This one Constraint can be defined as

$$P_{imin} \le P_i \le P_{imax}$$

Where P_{imin} and P_{imax} denote the minimum and maximum limits, respectively, of generating unit i.

III. QUANTOM COMPUTING BASED PSO

PSO gives populace based Search program, in which people are called halfway icles change, their situation after some time. In the PSO framework, Particles fly around in a multidimensional inquiry space. Every particle alters its situation as per own understanding and experience adjacent particles, utilizing the best position It is experienced without anyone else and its neighbors. Ideal in multidimensional space looking for an answer for move each particle in the gathering Get the best point by including speed position. Particle speed is influenced three segments, to be specific latency, psychological and society. The inertial segment reenacts the inertial conduct of winged creatures flying the past way. The Cognitive parts mirror the memory of feathered creatures about its best area and social the segment reenacts the memory of winged creatures the best area in a portion of the icles. Particle development around the multidimensional hunt space until the point when they locate the best arrangement. Adjustment speed of each can utilize current speed and count specialist the separation to Pbest and Gbest is as per the following.

$$V_i^{k+1} = W \times V_i^k + C_1 \times r_1 \times (Pbest_i^k - X_i^k) + C_2 \times r_2 \times (Gbest^k - X_i^k)$$

Where, V_i^kThe speed of individual i when iterating k, X_i^k Individual i is in the position of iteration k, W inertial weight C1 , C2 acceleration factor, $Pbest_i^k$The best position of individual i in iteration k, $Gbest^k$ Group's best position until iteration k r1 , r2 Random number between 0 and 1. Accelerate during this speed update the coefficients C1, C2 and the inertia weight W are Predefined and r1, r2 are randomly generated uniformly The number is in the range [0, 1]. In general, inertia the weight W is set according to the following equation:

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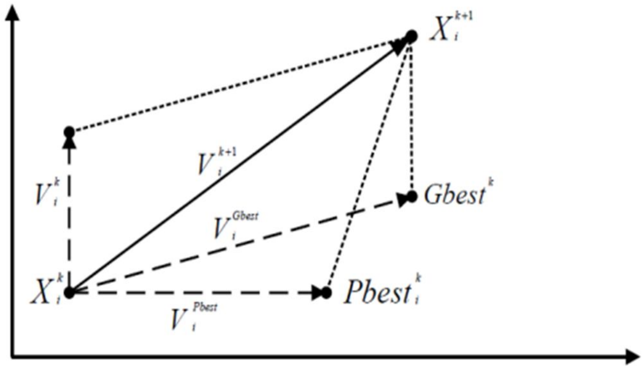

Fig 3.1 the search mechanism of PSO

The modified velocity equation (6) is given by:

$$V_i^{K+1} = K.\left(W.V_i^k + C_1 G_d()\left(Pbest_i^k - X_i^k\right) + C_2 C_d()\left(Gbest^k - X_i^k\right)\right)$$

$$K = \frac{2}{\left|2 - \varphi - \sqrt{\varphi^2 - 4\varphi}\right|}$$

Where $\varphi = C_1 + C_2, \varphi > 4$

The convergence characteristic of the system can be controlled byφ. Contraction factor method (CFA) φ must be greater than 4.0 to guarantee stability. But as φ Increase Factor K is reduced, diversification is reduced, Produces a slower reaction. Usually when Using shrinkage factors, φSet to 4.1 (ie C_1, C_2 = Therefore, the constant multiplier K is 0.729.QPSO, proposed and developed by Sun et al., is the expansion of PSO in the field of quantum computing. The concept of qubits and revolving doors is here to introduce the improvement of demographic characteristics Diversity. Qubit and angle Represents the state of the particle rather than the position and the particle velocity completed in the basic PSO. Thereby, QPSO has powerful search capabilities and powerful search capabilities Fast convergence feature. The basic difference between a qubit and a classical bit is the latter can stay at the same time Superposition of two different quantum states,

$$|\psi\rangle = \alpha|0\rangle + \beta|1\rangle$$

In the above equation, $\alpha$and $\beta$are complex numbers that satisfy the equation

$$|\alpha|^2 + |\beta|^2 = 1$$

The rotation state is represented by | 0> and the rotation state is It is represented by | 1>. As can be seen from (1), a qubit is Represents two information states (| 0> and | 1>) simultaneously. This superposition state can also expressed as

$$|\psi\rangle = \sin\theta|0\rangle + \cos\theta\,|1\rangle$$

Where the phase of the qubit is represented by□□□□the relation among □□□□and □□□The relation among □□□□and□□□can be defined as the position of the particle in QPSO can be described as□□□□arctan□□$x_{id} = p_{id} \pm \frac{L}{2}\ln\left(\frac{1}{u}\right)$ Where x_{id} is the position of the ith particle and p_{id} is local attractor of particle i is located between pbest and gbest and u is a uniformly distributed random number in the range [0,1]. The value of L can be used following equation

$$L = 2\alpha|x_{id} - p_{id}|$$

Where □□is the only parameter of QPSO, which can be calculated using the following equation

$$\alpha = (1 - 0.5).\frac{t_{max} - t}{t_{max}} + 0.5$$

And the local attractor p can be represented as below

$$p = \varphi.pbest + (1 - \varphi).gbest$$

Where φ refers to a uniformly distributed random number. The range of φ is [0, 1]. Figure 1 depicts a flow chart of the QPSO. In the first step, Algorithm parameters, such as population size, particles initialize the dimension and the maximum number of iterations. The second step is to evaluate the fitness of each particle and Record pbest and gbest.

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IV. RESULTS

The research work done in this dissertation is associated with the minimization of fuel cost and emission dispatch while maintain the network constraints with consideration and non-consideration of valve point effect.
The problems addressed in this research work are as follows-

A. Formulation of economic load dispatch for different test systems.
B. Implementing economic load dispatch problem considering valve point effect for different test systems.
C. Implementation of economic load dispatch problem using modified particle swarm optimization for valve point effect for different test systems.
D. Implementation of combined emission and economic load dispatch using improved cost function and quantum particle swarm optimization.

This system consists of 13 generating units and the input data of 13-generator system are given in Table . In order to validate the proposed Modifed-PSO method, it is tested with 13-unit system having non-convex solution spaces. The 13-unit system consists of thirteen generators with valve-point loading effects and have a total load demands of 1800 MW and 2520 MW, respectively output.

Table-1 Parameter's Value of Constraints Parameter

Parameters	Values
PopulationSiz	1000
Maximumiterat	100
Number	100
Dimension	6

Table 2
Power Data for Test System of 6 Generators

Generating	*Pmin*	*Pmax* (MW)
1	50	200
2	20	80
3	15	50
4	10	50
5	10	50
6	12	40

Table 3
Data for 6 Generator System with Emission Coefficients

a_i	b_i	c_i	d_i	e_i	f_i	g_i	h_i
0.0010	0.0920	14.50	-136.00	0.0015	0.0920	14.0	-16.0
0.0004	0.0250	22.00	-3.50	0.0014	0.0250	12.5	-93.5
0.0006	0.0750	23.00	-81.00	0.0016	0.0550	13.5	-85.0
0.0002	0.1000	13.50	-14.50	0.0012	0.0100	13.5	-24.5
0.0013	0.1200	11.50	-9.75	0.0023	0.0400	21.0	-59.0
0.0004	0.0840	12.50	75.60	0.0014	0.0800	22.0	-70.0

Table 1indicates the basic parameters of particle swarm optimization technique used for simulation. Table 2 indicates the power constraints for 6 generator system and table 3 explains the data required for system modeling for developing emission dispatch problem for multiple objective optimization system.

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Table 4
Comapartive Analysis of Combined Emission and Economic Dispatch of Proposed Method

Power	Lagrange	SA	PSO	QPSO	MPSO
P1	50.65	50	50	50.00	50.00
P2	21.20	20.00	20	20.00	20.04
P3	15.46	15.00	15	15.00	15.057
P4	22.6846	20.61	22.11	22.9	22.208
P5	21.3002	22.49	20.6	20.04	22.63
P6	21.1181	21.89	22.31	22.03	20.06
Fuel Cost ($/h)	2734.21	2702.78	2701.796	2701.476	2058.5
Emission	2642.702	2607.46	2593.1844	2583.6485	2440.4

Modified QPSO technique is successfully implemented to solve multiobjective CEED problem. Here, CEED is represented using cubic criterion function. Unit wise max/max price penalty factor is considered to convert both objectives into a single objective. Simulation results verify the effectiveness of QPSO in solving this multiobjective problem by achieving reliable, robust and suitable solutions with fast convergence characteristics. The obtained results are compared with other well-known methods like Lagrangian relaxation, PSO and SA which demonstrate QPSO's superiority over these methods to solve the CEED problem. Small numbers of generating units have been considered in this research due to the unavailability of data for large power generation systems.

Table 5
Result for 13 Generator System Valve Point Effect

Unitpoweroutput	NN-EPSO[20]	MPSO
P 1	490.0000	269.263671702
P 2	189.0000	150.750185936
P 3	214.0000	224.858126186
P 4	160.0000	112.081379788
P 5	90.0000	157.271376553
P 6	120.0000	158.473867494
P 7	103.0000	106.176428015
P 8	88.0000	158.919165718
P 9	104.0000	159.451200806
P 10	13.0000	77.5031323538
P 11	58.0000	101.999849738
P 12	66.0000	92.4841327770
P 13	55.0000	92.7117782526
Total Power Output (MW)	1800	1800
Total Generation Cost ($/h)	18442.5931	18100.145

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V. CONCLUSION

This research centers around estimation and incitement of economic load dispatch issue under various working conditions. It likewise gave the arrangement including valve point impact and losses for various test frameworks. Accordingly, three points were built. Initially, built the numerical model of economic and outflow load dispatch with cubical cost works under valve point impact and non-valve point impact with and without losses. Second one is to explain numerical aftereffects of economic load dispatch with altered quantum particle swarm optimization. The third one is similar investigation of reproduced results with existing soft computing issues. This research fundamentally considered the enhanced quantum PSO technique. It is utilized to give the arrangement including numerical investigation. The adjusted PSO technique requires less number of cycles to achieve union, and is progressively exact and not delicate to the variables.

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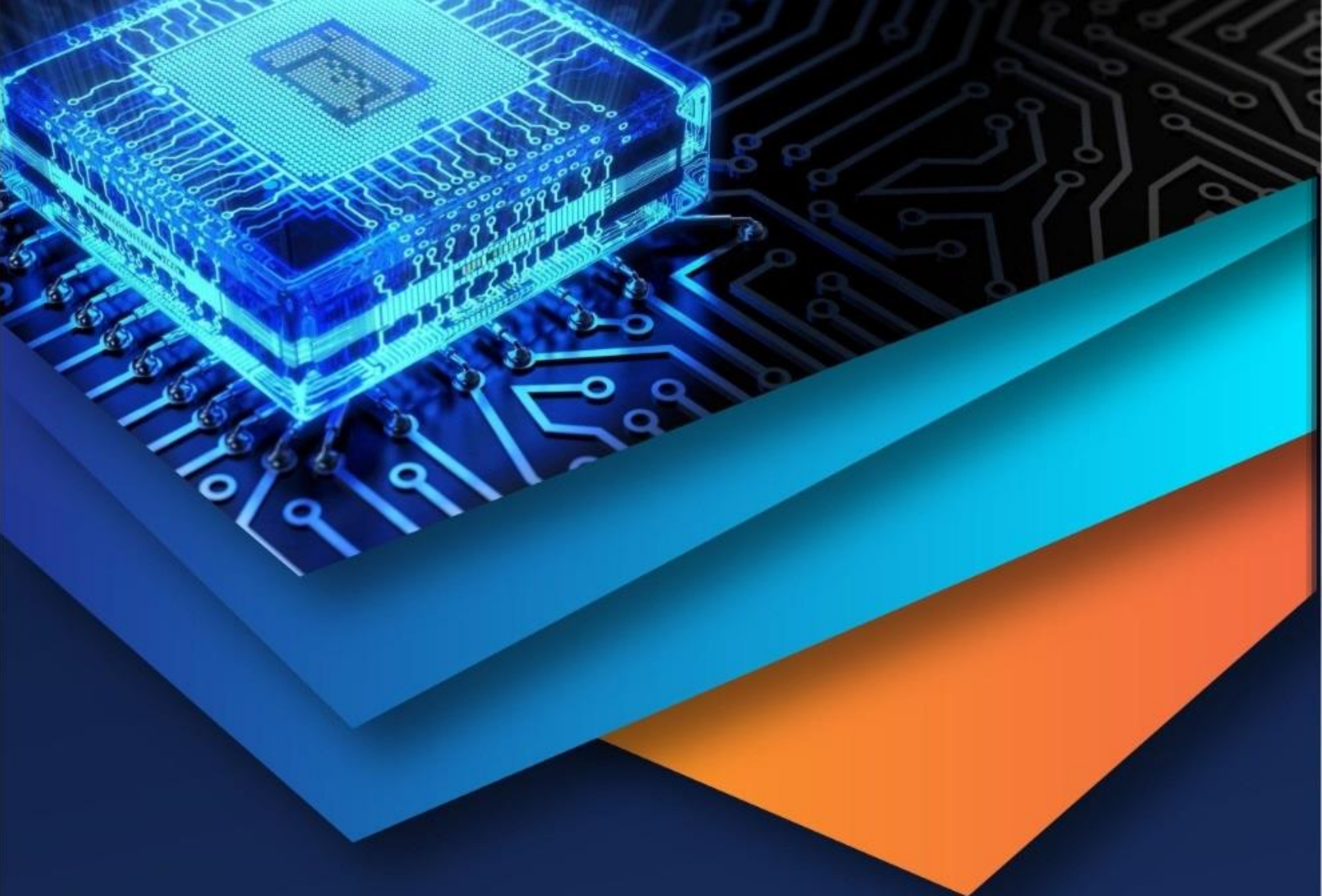

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