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Case Study Retrofitting an Existing Building for Griha Green Building Certification

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Abstract: ***The infrastructure business in India is rapidly increasing. Infrastructure is the most major hindrance to the growth of Indian businesses in India. Existing buildings account for 45 percent of worldwide energy use in the current condition. These constructions' greenhouse gas emissions are mostly to blame for global warming, acid rain, and other environmental difficulties. We can reduce our dependency on limited natural resources like power, water, and materials which use in building while simultaneously enhancing our contribution to environmental quality by incorporating green building themes into the design, construction, and maintenance of buildings, and restoration of our houses.***
It is a common misconception that only new buildings can be certified as green building, however this is not true. Existing buildings may be made certified green by taking certain step. With each existing building's effort in adopting the existing green building strategies, an enormous effect in combating global warming will be anticipated in return.
GRIHA provides green building certification at various levels. There are several ways for meeting these objectives with the cooperation of humans and the use of modern technology and procedures. In retrofitting existing building for GRIHA certification, aspects like site availability, energy efficiency, water efficiency, renewable energy, natural lighting are taken into account. The present paper presents the retrofitting required to transform an existing building to a certified green building with ease and cost effectiveness.
Keywords: GRIHA; Sustainable development; Green building; Existing Building; Environment.

I. INTRODUCTION

A green building is one which uses less water, optimizes energy efficiency, conserves natural resources, generates less waste and provides healthier spaces for occupants, as compared to a conventional building. Green Building is a design concept that reduces buildings' environmental impact through innovative land use and construction strategies. To provide a healthy indoor and outdoor environment, a Green Building incorporates the use of clean, renewable energy as well as the efficient use of natural resources and recycled or recyclable materials. In recent decades, the global green building trend has grown rapidly. The concept of green building certification has also gained traction in India. This is consistent with a global trend in which rating tools set benchmarks for green measures for building construction and operation in order to make them more sustainable and reduce their negative environmental impacts. Modern sustainability programmes, need an integrated and synergistic design approach in both new construction and retrofitting of existing facilities. Sustainable design, connects the building life-cycle with each green practise utilised with a design-purpose to generate synergy among the practises used. There are several benefits to building green, including environmental, economic, and social benefits. Green construction incorporates a wide range of methods, techniques, and abilities to decrease, and eventually eliminate, buildings' environmental and human health consequences.

Green buildings may have any of the following characteristics:
• Solar or another form of renewable energy
• Efficient energy and water resources
• Good indoor air quality
• Adaptable design for changing environment
• Amount of waste produce will be less in comparison to commercial building
• It follow the concept of 3R i.e. reuse, recycle, reduce
• Designing and construction method that considers the quality of production of tenants
• Environmental health can be improved

Some of the aspects that may influence green architecture are culture, environment, climate, economics, and resources. GRIHA grading systems are used in green building design, construction, operation, and maintenance. This project is based on and complies the GRIHA grading system. There are preset rules for building design, construction, and operation that indicate whether or not their performance has a detrimental influence on the environment. It usually emphasises the utilisation of renewable resources, such as sunshine via passive solar, active solar, and photovoltaic technology, and plants and trees via green roofs, rain gardens, and rainwater run-off reduction.

According to Green Rating for Integrated Habitat Assessment (GRIHA), points are allocated to a building based on the amount of green measures taken, and after suitable weighting a total score is assigned to calculate the structure's rating. This helps to demonstrate the scope of green measures implementations in building construction. The present project is retrofitting of an existing building, which integrates variables such as energy efficiency, water efficiency and renewable energy for GRIHA certification requirements.

II. OBJECTIVE

The objective of the present article is document case study where existing building might retrofitted into a green building be implementing specific measures at an affordable level.

In this project a preselected building studied and all data required for the building to be a GRIHA certified green building is prepared. The retrofitting of the building was to be conducted for it to be feasible to receive two-star rating. It will incorporate any affordable and space-saving conversions. Following the 2 star certification, the building will be able to use renewable energy and reduce the consumption of other energy sources.

III. GRIHA FOR EXISTING BUILDING

Site Parameters, Maintenance & Housekeeping, Energy, Water, Human Health & Comfort, Social Aspects, and Bonus Points are the 12 criteria organised into seven categories of the GRIHA for Existing Building grading system. Six of the twelve conditions must be met, while the remaining six can be skipped. Except for the six necessary requirements, each criterion has a number of points incorporated within to it.

All functioning buildings with a greater than 2,500 square metres of built-up area are potentially eligible for GRIHA for Existing Building certification. To be feasible for certification a minimum of 25 points in mandatorily required. For the present project retrofitting for 2star rating was considered which requires 41-55 points

IV. DETAILS OF CASE STUDY

The building in the present case is the Engineering building within an Institutional area in the city of Agra
Location-Agra (Uttar Pradesh)
Area of college-28 acre
Occupancy hour =7-8 hour
Building type –Institute
Orientation of building-North-East
Water source-Groundwater bore well
Selected area-Three levels (Ground, First and second floor area)
Building for study -2 floor + ground floor
Study rooms-14 classrooms on every floor
Total rooms=42(for three floor)
Build up area=850m^2

V. METHODOLOGY ADOPTED

A. Energy saving

Photovoltaic technology is crucial in solar energy applications. Depending on the brief and nature of the project, non-air-conditioned (non-AC) and air-conditioned (AC) areas are addressed differently. Natural ventilation, passive techniques, and low-energy evaporative cooling solutions are used in non-AC environments to enhance thermal comfort levels. The AC zones are intended to reduce the load on the building's installed HVAC systems and, as a result, its energy consumption.

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B. Lighting

Artificial lighting can use up to 15% of a building's annual electricity usage. Building lighting energy consumption may be lowered by 50-70 percent by utilizing existing illumination technology and planning to reduce the need for artificial lighting.

The use of green lighting is in keeping with the environment. Lighting sections for different locations or purposes should be on separate controls, allowing users to choose how much light is needed. Day lighting possibilities should be taken advantage of while glare and unwanted heat gain are minimized.

C. Day lighting

This selected building is mostly for daytime usage. Therefore maximum use of day lighting can save lot of energy. The light shelves on a south-facing wall reflect sunlight even deeper into the interior of the area. Natural light in a building decreases the need for artificial lighting, which is beneficial to the structure's residents. Summer day lighting relies on gentle, diffuse Instead of direct sunlight, use skylight and reflected light.

D. Orientation

In the summer, south-facing windows with enough overhangs provide indirect light, and in the winter, they provide both heat and light. In the morning and evening, east and west facing windows allow in light, but in the summer, they can generate glare and heat. Because they normally give equal, glare-free light and practically no undesired summer heat gain, north-facing windows play important role in giving day lighting.

E. Solar power plant

Solar energy is the most commonly available source and is cost-effective in a variety of ways. Easy erection, rapid generation, easy maintenance, tailor-made projects and tie grid projects, may be taken into account. At an educational institution, the lighting load uses the bulk of the power. Lighting, fans, and computers are examples of such equipment. There are power appliances at institutes such as air conditioners, projectors, heaters. Because the wiring system provides a separate wire channel for the light and power circuits, it is straightforward to equip the light circuit with a solar power system.

- *Off grid system*

A self-contained solar system that operates independently of the utility grid is known as an off-grid solar system. Solar panels, an off-grid solar inverter, solar batteries, and numerous solar accessories make up an off-grid solar system. This method is design to offer long-term power backup during power outages or at night.

Solar panels capture sunlight during the day and deliver electricity to your linked load at night. Solar batteries can be used to store excess or unused solar energy until it is needed.

- *On grid system*

A solar system that is directly linked to the public grid is known as an on-grid system. This solar system provides directly power your load with the electricity it generates. Whenever solar panel can produce less energy than requirement than grid will provide energy. Whenever production is more that requirement extra energy store in grid. However, this alternative is only available while the main government grid is operational.

F. LED light

LEDs have been demonstrated to be more efficient than traditional light fixtures. LED lighting fixtures are becoming increasingly popular as a means of promoting energy conservation and lowering power expenses. Following that, LEDs may make a significant contribution to environmental conservation. LEDs are termed Green Technology because of its multiple benefits and innovative features, and they help to conserve the environment.

LEDs (Light Emitting Diodes) are semiconductor-based light sources.

G. Air-Conditioners (A.C)

All of these processes are powered by refrigerant, which is a chemical that is generally present in a liquid or gaseous state. A refrigerant generates cold air by absorbing heat from its surroundings and mixing it with other components such as compressors and evaporators. With the help of copper coil it give cool air around. R 32 AC is most environmental friendly and lowers the Ozone Depletion Potential (ODP).

R32; R32 is another refrigerant that is widely used by air conditioning manufacturers due to its environmental, energy consumption, efficiency, and safety performance. In comparison to other variant it has low GWP. These refrigerants have an ODP of 0. It consists of organic hydro fluorocarbon compound. Currently, R-410 A is most commonly used in India.

- The GWP of R32 is 674, which is lower than R-410A.
- R32 systems use up to 20% less refrigerant than R-410A systems, resulting in higher efficiency and lower operating costs.
- R32 has no potential for ozone depletion.
- Because R32 is easier to recycle than R-410A.

H. SRI Coating

SRI paint improves the surface's capacity to reflect solar heat. When selecting a highly reflective roof coating, the Solar Reflective Index (SRI) becomes an essential metric since it keeps the roof cool, decreases the internal temperature, and lowers the cooling cost of a building. The quantity of solar energy reflected away from the building and back into the atmosphere is referred to as solar reflectance. The higher a coating's solar reflectivity, the less heat the building must absorb.

I. Grass Paver Block

Grass block is option to solve some of the problems associated with the early pre-cast approach. A flat upper surface is safer for pedestrians and lowers road vibration, which are both problems with studded blocks. Another advantage is that each soil pocket has a continuous concrete border, which frees up grass blocks for slope protection work and keeps dirt from running down the hill.

J. Vermin Composting

Kitchen scraps and other green trash are turned into a rich, black soil that smells like earth and feels like magic by vermin composting often known as worm composting. It's a type of super compost that's virtually completely made up of worm castings. It's abundant in nutrients, but it's also high in microorganisms, which help develop and maintain healthy soil. Because it is often made in modest quantities, vermin compost is commonly used as a top or side dressing for one's most demanding and deserving plants. When combined with regular compost, it enhances garden soil. When combined with potting soil, it energises plants growing in pots, whether outside or indoors (properly made vermin compost has a slight, natural smell and is perfectly suitable for indoor use). This is the process of turning waste into useful manure.

VI. CALCULATIONS AND RESULT

On ground of GRIHA manual for existing building here is list of mandatory criteria after that criteria for point. This calculation is for 2 star certifications. Calculation includes proposals and cost required to achieve points.

TABLE-1
MANDATORY POINTS

CRITERIA	DETAIL		SPECIFICATIONS	UNIT COST	TOTAL COST
Mandatory 3.1.1	Need to give checklist	Table-1.1			
Mandatory 3.1.2	AC should be R32	Need to replace 3 ac out of 5	(Hitachi 1.5 ton 3 star split AC ZUNOH 3100F-R32)	32690	1,07,070
	Fire Fighting equipment should be halon-free	Already have			
Mandatory 4.1.1	Meter required	3 meters	Meters with RS-485 PORT	45600*3	136,800
Mandatory 5.1.1	Provide energy consumption details				
Mandatory 6.1.1	Renewable energy	Solar plant	Reduction must be 2.5%	Cover in criteria 6	
Mandatory 7.1.1	Water supply and usage	Through ground water	Washroom		
Mandatory 10.1	Maintaining good IAQ	Smoking must be banned	Policies are already have against smoking		
				TOTAL	2,43,870

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TABLE-2
Checklist for mandatory 3.1.1

S.No	Type	Check	Remark	
1	System of electricity			
	Transformers	Yes		
	Generator powered be diesel	Yes		
	Motor	Yes		
2	System of mechanical devices			
	Pumps	Yes		
	Fans for ventilation	Yes		
3	System of piping			
	Piping	Yes		
	Fittings and fixture	-	Available	
	Fire prevention is essential.	Yes		
	Sprinkler	Yes		
4	Metering and sensors			
	Meters that measure energy	Yes		
	Meters for water	Yes		
	Air quality meters	No	Need to install	
5	Renewable energy system (any one system)			
	Panel for solar energy	Yes		
	Solar thermal	No		
	a wind generator	No		
6	System for collecting rainwater	Yes	Available	

A. Criteria and their analysis

- *CRITERIA-2*

Criteria- tree per 80m^2
Tree should be there=1417
Already have= 650
Need to plant=767

TABLE-3
VERTICAL GARDENING-

No of pots	200*2	8000
Dimensions per pot	12:9.5:12.5cm	
Frame	2*2	16000
Dimension of frame	250*65cm	
Drip required for watering	12.5m*2	2174
Plants and seed		40,000
Manure		10000
Installation		8000
TOTAL		*84,174*

TABLE-4
TOTAL PLANT NEED TO BE PLANTED

Plants around park	100	10,000
Dimension of park	18*38m	
Total perimeter	112m	
Pots plants	266	13,300
Pots	266	5000
Total	1256	*28,300*

TO REDUCE URBAN HEAT ISLAND EFFECT

TABLE-5
SURFACE COVERING

Items	Area
Solar panel	300m^2
Grass pavers	On the passage to engineering Block
SRI paint on roof	200m^2
Grass paver	16m^2

TABLE-6
SRI PAINT

HIGH SRI COATING ALUMINIUM BASED PAINT	
ITEMS	QUANTITY
Area to be painted in whole	200m^2
Paint quantity necessary	10 litre
Paint's total cost	120 per litre
The price of labour	4300
Total price	*5500*

GRASS PAVER
The needed price for grass pavers;
Grass pavers are 0.5mX1.0m in size.
1 m X 16 m is the size of the paved surface.
The total number of pavers required is 32.
Each paver costs Rs. 55.
The total cost of pavers is Rs. 1,760 (55 x 32).
The cost of placing an order is Rs. 420.
Rs. 2180 is the total cost.
Using plain concrete brick pavers as a cost comparison
For the same space, the total number of pavers is 100.
Each concrete solid paver costs Rs. 36.
The total cost of the pavers utilised is Rs. 3,600.00 (100 x 36).
3.600 + 420 = Rs. 4,020.00 total cost including putting price
Using grass pavers saves money-

4,020 – 2,180 = Rs. 1,840.00 in total savings
As a result, because the concrete pavers are already there, just additional installation fees are required.
Now, the total cost of plain pavers is Rs. 1, 220 (420 + 800).
Total paver operation costs are Rs. 2,180 + Rs. 1,220 = Rs. 3,400.

- *CRITERIA-3*

TABLE-7
MAINTENANCE & WASTE MANAGMENT

Details				
Cleaning and pest control items that are good for the environment	Citronella oil	800/lt	4800	1 point
Buying appliances with a BEE rating of at least three stars	Cover in mandatory			1 point
Multicolour dustbin	3 set of dustbin	3*3500	10,500	1 Point
hygienic storage areas for various wastes	Behind the park, on the left side of the main gate, there is an area where no development is allowed, thus it is used for garbage storage.			1 Point
TOTAL			*15300*	

- *CRITERIA-5*

TABLE-8
ENERGY EFFICIENCY

ITEM	QUANTITY	PRICE	
CFL Bulb power	257/40watt	250 each	
Total -price of CFL	10,280watt	64,250	
LED bulb power	208/20watt	160 each	
LED in washroom	9/9watt	90each	
Total price of LED	4241watt	34,090	

Energy saved=10280-4241=6039
Cost saved=64250-34090=30160

Street Light

TABLE-9
STREET LIGHT

Items	No	Usage/ item	No of hour	Total energy	
Street light	12	120	10hr	14,400	
	7	80	10hr	5,600	
	8	50	10hr	4,000	
			Total	24,000	
Alternative					
Solar street light	6	30	10hr	1800	
	4	24	10hr	960	
	4	24	10hr	960	
			Total	*3,720watt*	

TABLE-10
COST ANALYSIS

Cost of solar light	Street light	85400
Cost of replacement of 4 ac		1,40,070
Cost of LED	20 watt LED	33,280
Cost of LED	9 watt	810
	Total	*259,560*

In all, there are 27 solar street lights, but only 14 are needed for this project since solar lights may not work correctly in the winter, thus electric lights will be utilized.
13 of the 27 lights will be powered by electricity.

- *CRITERIA-6*

  Generating electricity =200 unit/day
  Average price=2,100,000
  Annual saving 540,000
  Area required=300sqm

TABLE-11
SOLAR ENERGY

Items	Description
Solar plant	50kw
Power plant watt	400watt
Solar panel amount	125
Type of panel	Mono crystalline
warranty	25yr
Solar inverter	50kva
Inverter type	(On grid) solar inverter
Max DC input	50kw
Warranty	5yr
MC4 connector	100pair
Ac junction setup	1
DC junction setup	1
DC cable	400m
Ac cable	300m
Area needed	300sqm
Solar items	Lighting Arrestor, Fasteners, Cable Tie, Crimping Tool, Earthing Kit
Total cost	21,00,000
Unit generation per yr	72,000 units/year

Replacement costs:
Ac (R32) =16,065
Street light=20,280
Building=21,270
Total=57,615watt=57.615kwYearly=186,672.6RS at a rate of 9rs=518.5RS

- CRITERIA-11

TABLE-12
UNIVERSAL ACCESSIBILITY

LOCATION	INFORMATION	AREA(INCH)	UNIT COST	TOTAL COST
TOILET	Accessible toilet	6*9=54	11/inch	594
RAMP	Ramp access	6*7=42	11/inch	462
MAIN OFFICE	Cabin1 cabin 2 cabin3 cabin4 cabin5	4*6=24 4*6=24 4*6=24 4*6=24 4*6=24	11/inch	264 264 264 264 264
DRINKING WATER	Distilled water	6*7=42	11/inch	462
PASSAGE	Office ahead Entrance here Staircase	6*8=48 6*8=48 6*8=48	11/inch	528 528 528
RULES	No smoking No spitting	4*5=20 4*5=20	11/inch	220 220
			Total	4862

TABLE-13
COSTING

Changes	Cost
Information board that space is reserved for wheel chair user	750/sq feet
Ramp on stairs	For 11 ft ramp= 4000/ft=44,000 For 1 stair=700
Bar handle for rooms 1400mm	485rs (12 inch stainless steel)
Toilet	5000
A washbasin near entrance for handicapped	5000
A hand rail near seat	450*2=900 (12 inch)
Brail signage at door	11/sq inch 4862rs
Total	61,697

- CRITERIA-12

TABLE-14
VERMI COMPOSTING

COST OF VERMICOMPOSTING	
excavation cost	800
Construction cost	21,000
Total	21,800
5% extra	1090
Total cost	22,890
Cost for earthworm	4,900
TOTAL	27,790

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VII. CONCLUSIONS

After study and understanding of GRIHA rules and their given criteria and selected building for analysis this table is prepared in which possible earlier and after given and cost required given.

After study and data collection this is found that there is scope for retrofitting an existing building for green building. According to calculations this building will be able to get two star certifications with lots of benefits.

As population and pollution increases rapidly this is high time to adopt green building and after this study this is clear that not only new building can be green building but also existing building can be green building. Only need of some changes and in affordable range.

TABLE-15
FINAL POINTS

Criteria	Points Earlier	Points gained	Cost required
Mandatory	-	-	2,43,870
Criteria 1	2	2	0
Criteria 2	1.5	4	113,730
Criteria 3	0	4	15,300
Criteria 5	0	15	259,560
Criteria 6	1	10	21,00,000
Criteria 11	2	5	66,559
Criteria 12	0	2	27,790
TOTAL	7.5	42	*28,26,809*

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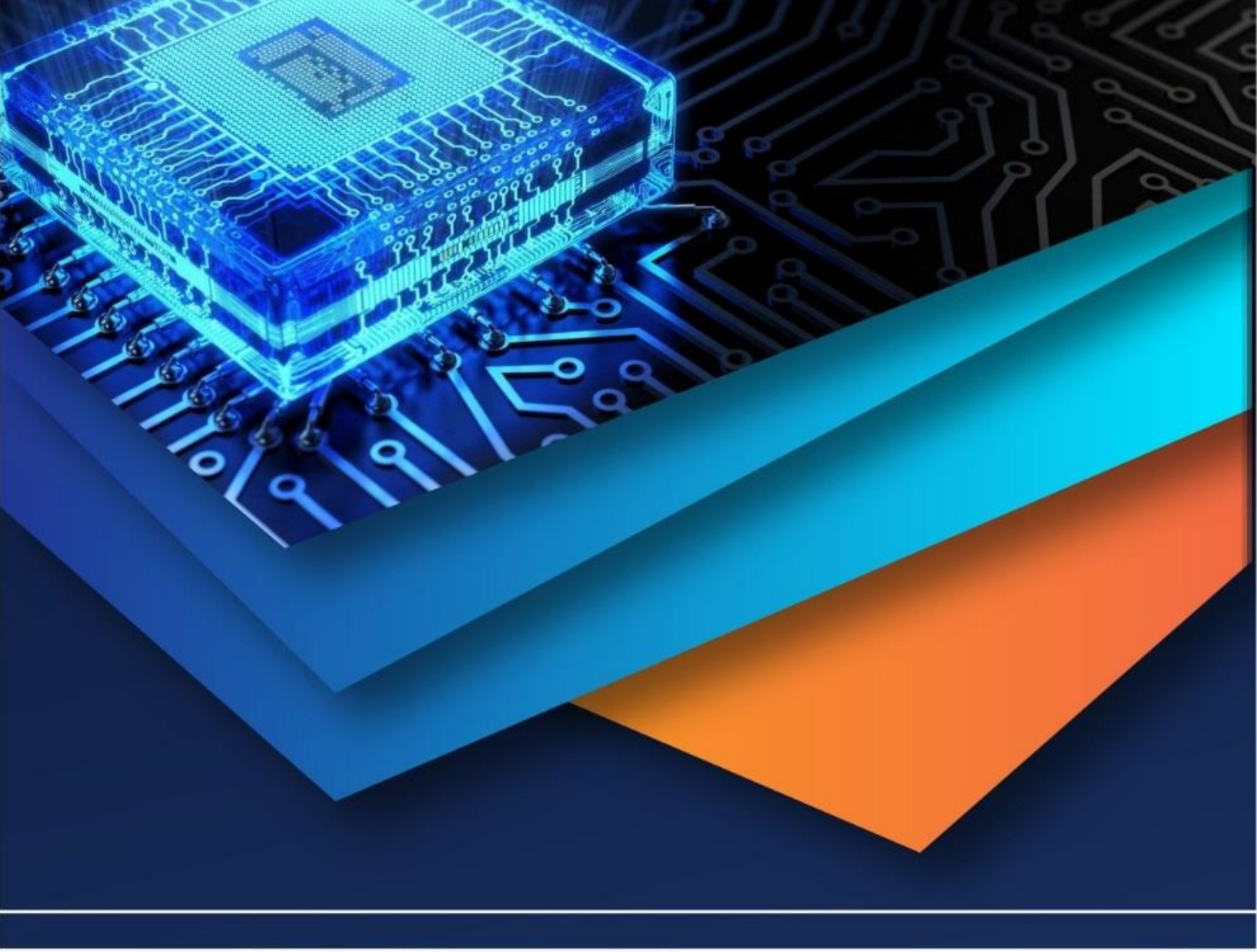

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