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Design and Implementation of Reliable Solar Tree

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Abstract: - Flat or roof top mountings of Photovoltaic (PV) structures require large location or land. Scarcity of land is greatest problem in towns or even in villages in India. Sun strength Tree presents higher opportunity to flat mounting of PV systems. For domestic lighting fixtures and other applications use of solar Tree is extra relevant whilst PV system is to be used. Sun tree is an innovative city lights idea that represents a really perfect symbiosis among pioneering layout and like-minded technology. In this paper load, PV, battery and tilt angle requirements estimated for solar tree. The optimum tilt angle for Sikar, Rajasthan calculated i.e. Latitude=27.5691 and Longitude=75.14425. The power output of 240Whr with battery unit of 30Ah, 12V was calculated.

Keywords— Photovoltaic, Sun, Solar Tree, Tilt Angle, Sikar Rajasthan;

I. INTRODUCTION

It is a form of renewable power resource that is some degree competitive with fossil fuels. Hydro power is the force of electricity of moving water. It provides about 96% of the renewable energy in the United States. Solar electricity is available in abundance and considered as the easiest and cleanest method of tapping the renewable power. For direct conversion of sun radiation into usable form, the routes are: sun thermal, sun photovoltaic and sun architecture. But the primary trouble associated with tapping sun energy is the requirement to put in large solar creditors requires a completely huge space. To keep away from this problem we will install a sun tree despite a no of sun panels which require a totally small space. A solar tree is an ornamental method of producing sun electricity and also power. It makes use of a couple of no of sun panels which forms the form of a tree. The panels are organized in a tree style in a tall tower/pole.

II. DESIGN AND WORKING PHENOMENA OF SOLAR CELL

A sun cellular (photovoltaic cell or photoelectric cell) is a solid state electric tool that converts the power of light without delay into power via the photovoltaic effect. The power of light is transmitted through photons-small packets or quantum of light. The method of conversion first requires a material which absorbs the sun energy (photon), and then increases an electron to a better energy nation, and then the go with the flow of this high-power electron to an outside circuit. Silicon is one such fabric that uses such process. A solar cell shape is shown in figure 1 and a solar panel configuration in figure 2.

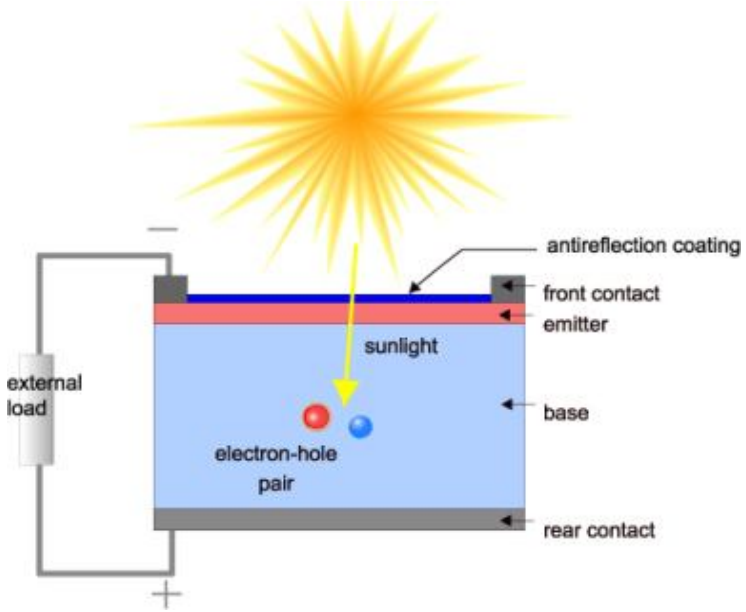

Figure 1 Building Blocks of Solar Cell

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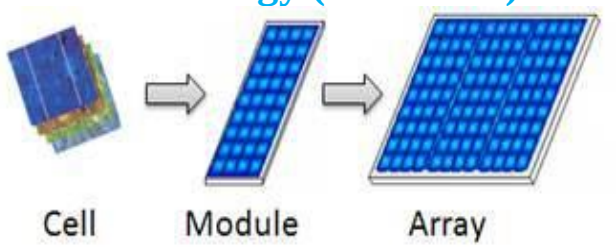

Figure 2: Solar Panel Configuration

A p-n junction: it is shaped by means of becoming a member of p-kind (excessive attention of hollow or deficiency of electron) and n-type (high attention of electron) semiconductor fabric. Because of this becoming a member of, excess electrons from n-kind try and diffuse with the holes of p-kind whereas extra hollow from p-type try to diffuse with the electrons of n-kind. Movement of electrons to the p-type side exposes wonderful ion cores inside the n-kind aspect, even as movement of holes to the n-type aspect exposes terrible ion cores inside the p-type side, ensuing in an electron field at the junction and forming the depletion region. Technology of contemporary in a sun mobile, called the "light-generated modern-day," includes vital strategies.

Absorption of incident photons to create electron-hole pairs. Electron-hole pairs will generate inside the sun cellular supplied that the incident photon has a strength more than that of the band gap. However, electrons (in the p-kind fabric), and holes (within the n-kind fabric) are meta-stable and could most effective exist, on average, for a period of time equal to the minority carrier lifetime before they recombine. If the service recombines, then the mild-generated electron-hollow pair is misplaced and no modern-day or power can be generated.

Collection of these carriers via the p-n junction prevents this recombination by using the usage of a p-n junction to spatially separate the electron and the hole. The vendors are separated through the action of the electrical area present on the p-n junction. If the light-generated minority carrier reaches the p-n junction, its miles swept throughout the junction by way of the electrical field at the junction, wherein it's far now a majority provider. If the emitter and base of the sun cell are connected together (i.e., if the solar mobile is short-circuited), then the light-generated vendors go with the flow via the outside circuit.

Photovoltaic effect: the collection of mild-generated carriers does now not via itself supply upward thrust to electricity generation. With a view to generate strength, a voltage ought to be generated as well as a cutting-edge. Voltage is generated in a sun mobile by means of a process known as the "photovoltaic impact." the gathering of light-generated providers by using the p-n junction causes a movement of electrons to the n-kind facet and holes to the p-kind side of the junction. Beneath quick circuit situations, the carriers exit the tool as light-generated contemporary.

Electric energy is saved in electromagnetic fields, which in turn can make a modern-day of electrons drift. Assemblies of solar cells are used to make sun modules that are used to seize power from daylight. When a couple of modules are assembled together (along with prior to installation on a pole-established tracker device), the resulting incorporated organization of modules all orientated in a single aircraft is referred as a solar panel. The electric energy generated from sun modules, is an example of sun electricity. Photovoltaic is the field of technology and studies associated with the sensible software of photovoltaic cells in producing power from light, though it's miles often used specifically to refer to the technology of strength from daylight. Cells are defined as photovoltaic cells whilst the mild supply isn't necessarily daylight. These are used for detecting light or other electromagnetic radiation close to the visible range, for instance infrared detectors, or dimension of light intensity.

A. Page Layout

Your paper must use a page size corresponding to A4 which is 210mm (8.27") wide and 297mm (11.69") long. The margins must be set as follows:

1) Top = Bottom= 19mm (0.75")
2) Left = Right = 14.32mm (0.56")

III. METHODOLOGY

On this work, we've got offered our concept that sun Tree concept for domestic electrification is large step to lessen power payments and dependence on grid energy that's unreliable nowadays in India. It additionally provides clean power source to lessen the worldwide warming. Power demand (load) of the small circle of relatives is taken into consideration and taken for determining the

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capacity of proposed system and device element sizes. All paragraphs must be indented. All paragraphs must be justified, i.e. both left-justified and right-justified.

A. Orientation of Solar Panels

India is placed in the northern hemisphere however towards the equator among latitudes 6˚ and 36˚N (the longitude boundaries are 68˚ and 980). The principal-most state, Madhya Pradesh, is limited inside the latitudes 21˚ and 27˚N. the gap of a degree of range is ready 111 km (sixty nine miles) as shown in figure 3.The terrain of India consists of Deccan plateau, the plains land beside the rivers, the Himalayan Mountain stages within the Northern component and the desolate tract vicinity in the West. The southern place has tropic rainy climate and the northern element is temperate.

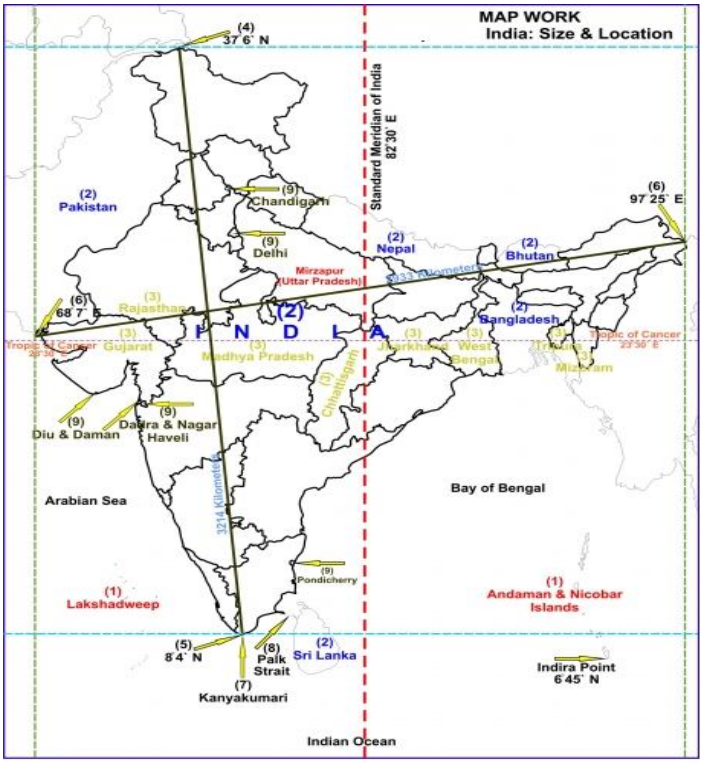

Figure 3 Physical Orientation of India

On the way to get the maximum from solar panels, they need to factor within the direction that captures most sunshine. In India, as anywhere in the northern hemisphere, sun panels ought to face southwards. But, in the southern hemisphere, as an example, in Australia panels need to factor towards north. Here North manner the real north – no longer the magnetic north as pointed by means of the compass needle.

Magnetic compass does now not constantly point to North. Surely, there are just a few places on the planet where it factors exactly to the genuine (geographic) North. The course wherein the compass needle factors is known as Magnetic North, and the angle among Magnetic North and the real North route is called magnetic declination.

Fortunately for India, the magnetic declination is rather small. As an example, at Delhi the declination is handiest 510 east and at Mumbai the declination is zero. 580 west. It way that the compass needle gives the path of geographic north is given pretty as it should be.

The entire document should be in Times New Roman or Times font. Type 3 fonts must not be used. Other font types may be used if needed for special purposes.

Recommended font sizes are shown in Table 1.

B. How to Determine the True South

There may be a clean technique to decide the true south: At sun midday, by way of definition, the sun shines from actual south and as a consequence the shadow solid via any object at solar midday will be along real south to actual north. The precise time of sun

midday isn't like the clock midday and changes barely at some stage in the year. Solar midday is precisely midway among sunrise and sunset, which can be taken from the neighbourhood newspaper of the identical day. Aside from walking from authentic south to true north, shadows forged at sun noon have the additional distinction of being the shortest shadows of the day.

C. Panel Orientation

For constant tilt attitude throughout the yr, the angle of the latitude is favoured i.e. one fixed orientation where the panel nearly always intercepts the greatest amount of solar radiation throughout the 12 months. Reference four claims that minor tweaking can yield 3 – 5 percentage greater benefit and typically recommend fairly decrease perspective for fixed tilt.

However, in general the horizontal tilt of the panels may be adjusted 4 instances a yr. at the latitude perspective in spring and autumn, (range – 15˚) in summer time, and (range + 15˚) in iciness. Instead, you will pick the perspective relying upon whilst the power requirement is best. If energy shortages are high in summer season and the requirement goes excessive due to the need of jogging lovers, then latitude – 15˚ have to be the proper choice. Every other properly manner is to adjust angles twice a 12 months for summer season and winter seasons. The great time to regulate for summer time perspective is mid-March and mid-September for the iciness angle. Following the 15˚ plus/minus rule, for Mumbai and Delhi you could set the panel angles as follows:

For Mumbai (range: 18˚ 55'N) summer time attitude 3˚ and the winter perspective 33˚.

For Delhi (latitude: 28˚ 38'N) the summer time attitude will be thirteen˚ and the iciness angle 43˚.

D. Tilt Calculation for Sikar Rajasthan

Latitude=27.5691 and Longitude=75.14425

If latitude is between 25^0 and 50^0, we the latitude 0.76 times plus 3.1degrees

Here latitude=27.5691^0

Tilt angle=0.76*27.5691 +3.1=24.0525=24.05^0

1) Adjusting the tilt twice a year

For northern hemisphere:

Adjust to summer angle on march 30 and adjust to winter angle on september 12

If latitude is between 25^0 and 50^0 then

Summer tilt angle= latitude *0.93=27.5691*0.93=4.6392=4.64^0

Winter tilt angle=Latitude *0.875 +19.2 =27.5691 *0.875 +19.2 =43.3229 =43.32^0

So

Adjust summer tilt angle at 4.64^0 on march 30

Adjust winter tilt angle at 43.32^0 on september 12

2) Adjusting the tilt angle four times a year

if latitude is between 25^0 to 50^0 then

for summer tilt angle= Latitude * 0.92 -24.3^0 =27.5691*0.92-24.03=1.0635=1.06^0

For spring and and autumn tilt angle = Latitude * 0.92 -2.3^0 =27.5691*0.92-2.3= 24.72^0

For winter tilt angle = Latitude * 0.89 +24^0 =27.5691*0.89 +24^0=1.0635=48.54^0

For northen hemisphere

Adjust to summer angle on 18^{th} April at 1.06^0

Adujst to automn angle on 24^{th} August at 24.72^0

Adjust to winter angle on 7^{th} October at 48.54^0

Adjust to sprin angle on 5^{th} march at 24.72^0

E. Load, Battery and PV calculation

1) Estimation of Load Requirement

LED Rating = 15w

Longest Night (Hours)=16Hr

Load requirement= E_L =15*16=240Whr

Deciding the system Voltage

The size of load is small so load voltage =12V

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2) *Estimation of Battery Requirement:*
The energy supplied by battery =240w at 12V
Required charge capacity = 240w/12V=20Ah
Assuming depth of discharge of the battery=70%
Usable battery sotage reqirement =20/0.7 Ah
The available commerical batter are 25Ah, 30Ah, 40Ah, 45Ah, 50Ah etc.
Let us use availabel battery unit of 30Ah, 12V

3) *Consideration of battery autonomy:*
Total required Ah=(Ah)daily + n*(Ah) daily
Considering autonomy of one day so n =1;
Total required Ah=30+1*30=60Ah
SO battery rating = 60Ah, 12V

4) *Sizing og PV Module*
As calculated above:
Energy supplied by battery, $E_b=E_l$=240Wh at 12V
Assuming battery efficiency is 90%, So the energy receieved by battery=240/0.9=266.66Wh
So the renergy supplied by charge controller to the battery = E_c=266.66 Wh
Assuming charge contoller efficiency=95%
So the energy suppled by solar panel to the charge controller=266.66/0.95=280.69Wh
Energy suppled by solar panel every day= 280.69/12=23.93Ah

5) *Calculating of fixed array*
Smallest day(hours)=4.20Hrs
The energy required form solar array=23.39/4.20=5.57Amp
Now if thake module of 12V and 4.55Amp then module required= 5.57/4.55=1.22=2Module
And if take module of 12V and 1Amp then modue required =5.57= 6Module

IV. DESIGN AND OUTCOMES OF SOLAR TREE

A prototype of proposed system is fabricated to check the feasibility of solar Tree system. Sun PV Panels are installed on a single tall pole (stem) with the help of suitable supporting base. The association of sun panels maintains a 'Phyllotaxy' pattern. Stems is made of M.S. pipe of 3"diameter and about 7 toes in peak. The top stem component locked by way of tightening the locking bolts. Structural assist for panels go base is used in order that the structure is balanced and undergo the weight performing on it. To assist the PV panels four fingers of spherical bent up pipe are welded to higher a part of the stem. Sun panels are mounted on attitude brackets on these arms of the tree. Attitude joints is adjustable and are made of stainless-steel and may be adjusted with the help of Allen key. With this device, solar panels can be willing to range or any other required perspective (winter and summer correction) manually to get maximum solar radiations. Refer fig 4 and fig 5. Figure 4 Shows tilted angle mechanism for adjustable for four positions.

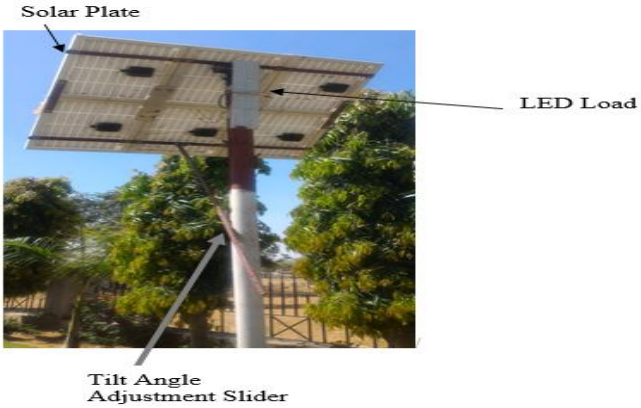

Figure 4 Designed Solar Tree: Tilted Angle mechanism

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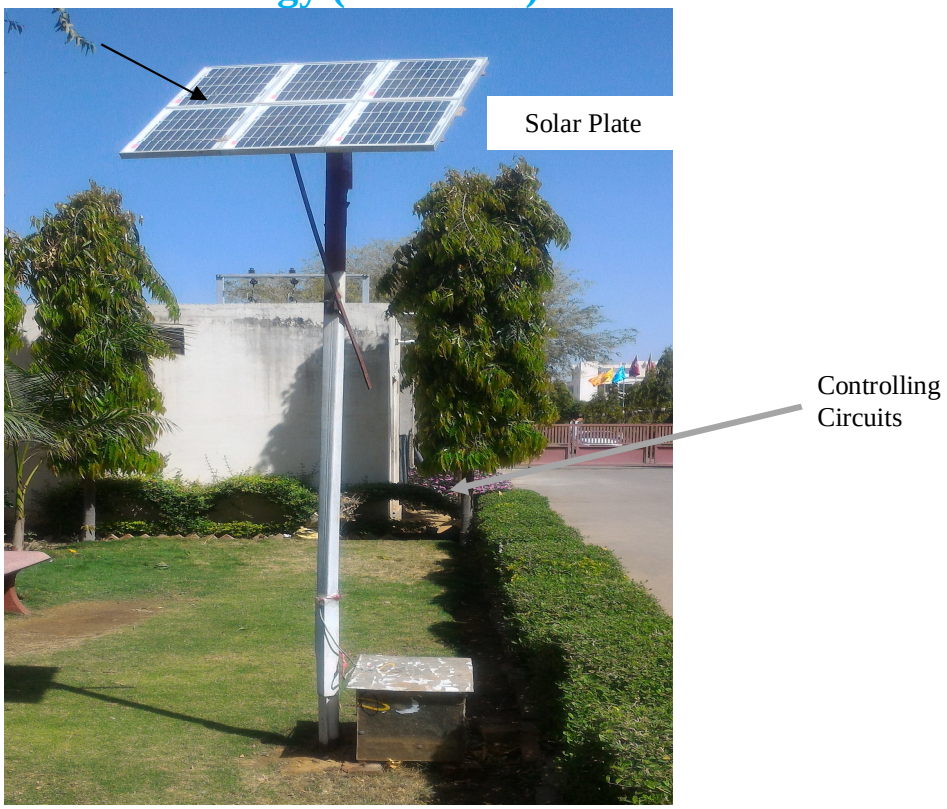

Figure 5: Solar Tree

V. CONCLUSIONS

For saving of land and fulfil the energy requirement, solar tree is complete these. Solar tree also solve the problem of power cut-off and less dependency on power grid. These system can be mounted on anywhere with 2x2meter of area. The cost of these solar tree depends on requirement of PV system according to load requirement. The tree can be made through local material so cost of tree can be reduced. The performance of solar tree better than other conventional solar mountings. The extended design of solar tree can be solve the energy consumptions problems. Government of Rajasthan also support and encourage use of solar energy system.

VI. ACKNOWLEDGMENT

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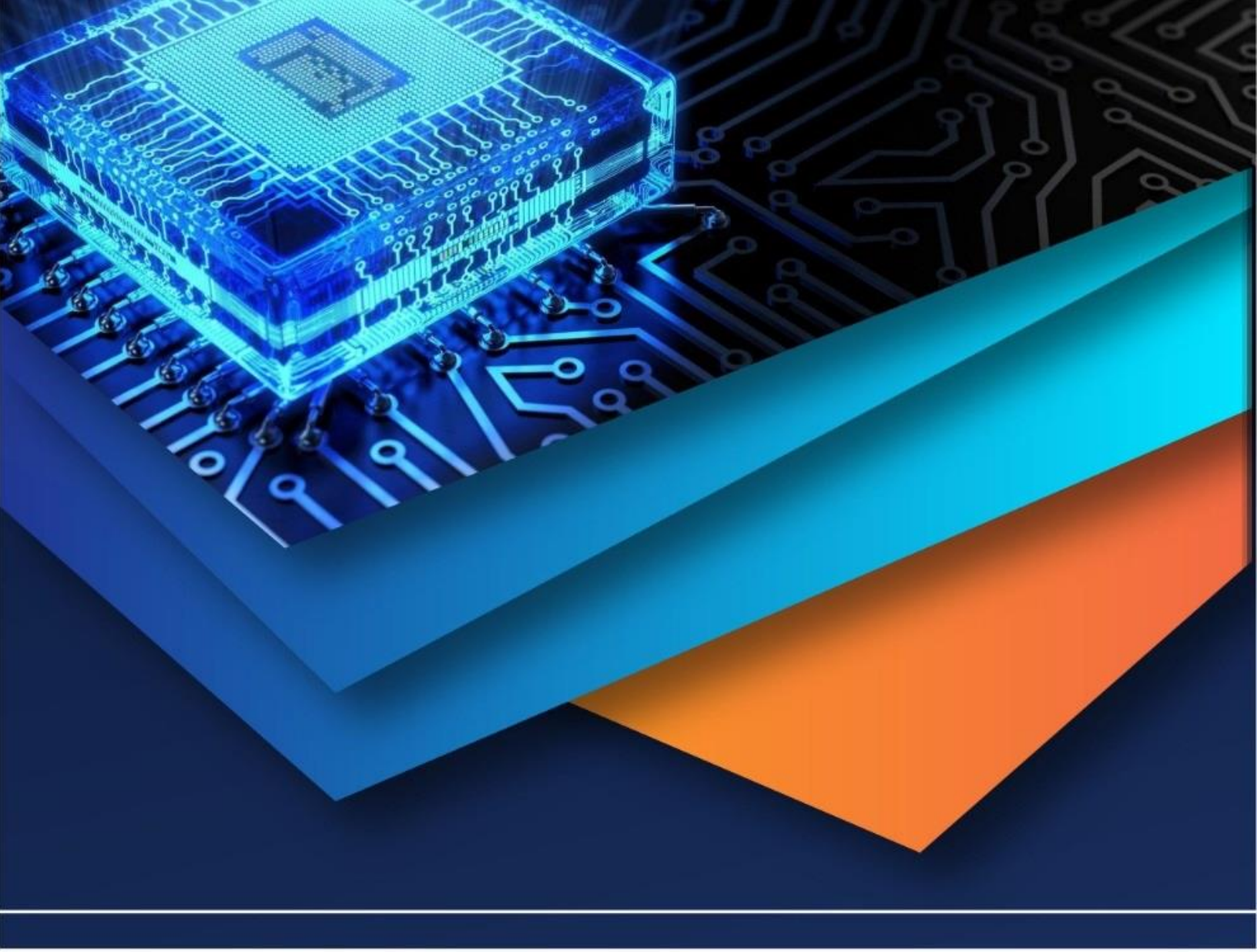

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