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Design and Analysis of Flexible Prosthetic Leg

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Abstract: ***The conventional prosthesis designs of fixed artificial legs are simple in construction. It consist of two basic parts a socket which connects residual leg with another part of artificial leg. They only provide support to the leg but they do not fully anticipate in the movement of the leg due to the fixed nature of leg and creates discomfort to the user. There is a need for design a new prosthesis leg with knee and ankle joints to perform movements during walking for the different angle of positioning of leg which help to improves comfortlevel to the user.***
Keywords: Prosthesis, residual leg, knee joint, ankle joint.

I. INTRODUCTION

A prosthesis limb also called artificial limb is an artificially made substitute for a limb lost through a congenital defect present at birth, accident, illness, or wartime injury. The construction of prosthesis depends largely on the job it will have to do. While cosmetic hands are concerned purely with appearance, prosthetic legs are substitutes for a major structural part of someone's body and have to bear their entire weight. So it needs tomake from a strong and durable but lightweight material such as carbon fibre, covered with foam Paddingor flesh-coloured plastic for the comfort purpose.Similarly while design the leg it is very important to consider the movement of leg at specific position. In this paper we are going to discuss about the movement of prosthesis leg while walking. On the basis of biomechanical design data we get the angle values for the different position of leg during walking. In this paper we design a prosthesis leg to achieve the required angle at knee and ankle joint to improve comfort level. Simulation of design leg had in HYPERMESH which give simulated results for displacement for different positioning of leg.

II. PARTS INVOLVED IN PROSTHETIC LEG

A. Upper limb Socket

The connecting part of prosthesis is called socket and it's carefully moulded around a plaster cast taken from the residual limb. The fit of a socket has to be precise or the new limb may damage the residual one, causing discomfort. More precisely fitting sockets can now be made by scanning a patient's residual limb with lasers and cutting-edge techniques such as 3D printing are also now being used.

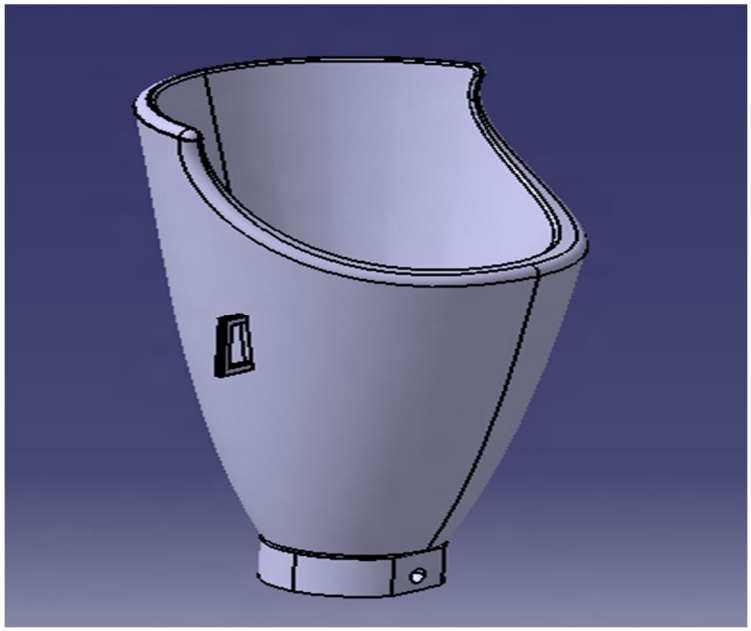

Fig. 1 upper limb socket

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B. Knee joint

The knee is the largest synovial articulation and has the largest synovial reservoir in the human body. In the present work to design knee joint the four bar mechanism is used.A four-bar mechanism is a simple closed-chain linkage composed of four bars and joined by four pivoting connections.This mechanism provides efficiency of motion, strength and stability.

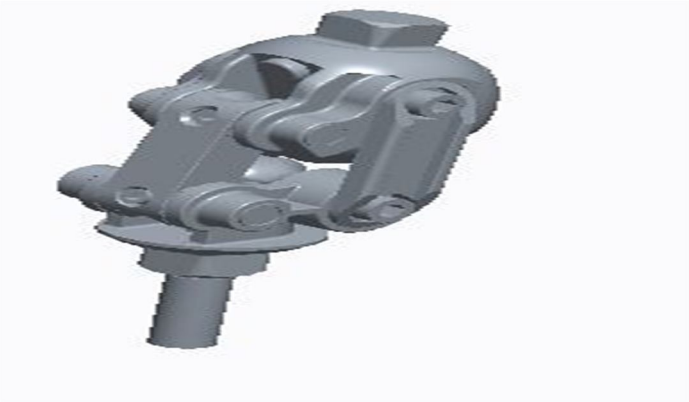

Fig. 2 knee joint

C. Lower limb

A transtibial prosthesis is an artificial limb that replaces a leg missing below the knee. It is used to connect the knee joint and ankle joint.

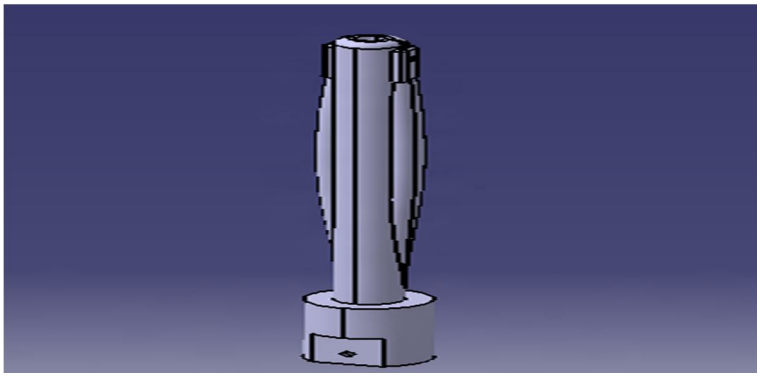

Fig. 3 lower limb

D. Ankle Joint

The ankle joint is a hinged synovial joint with primarily up-and-down movement (plantar flexion and dorsiflexion). The ankle joint design which is easy to manufacture as well as it is cost effective.Following figure shows, the ankle joint which is of C-type design to provide the primarily up-and-down movement. Which is design for 3 to 7.5 mm plate for better result.

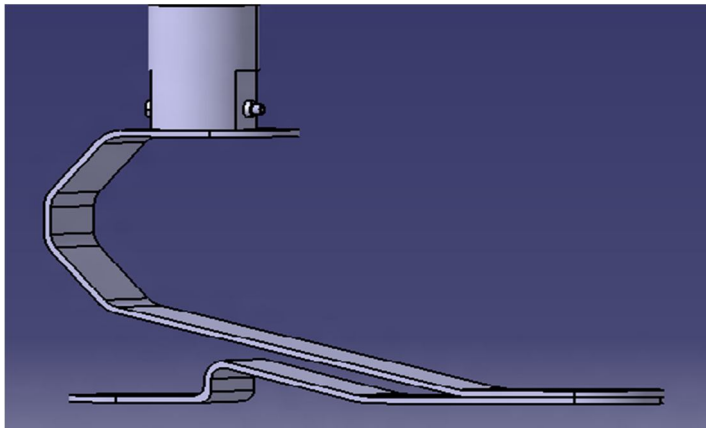

Fig.4 Ankle joint

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E. Assembly

The following figure shows the assembly of prosthetic leg.

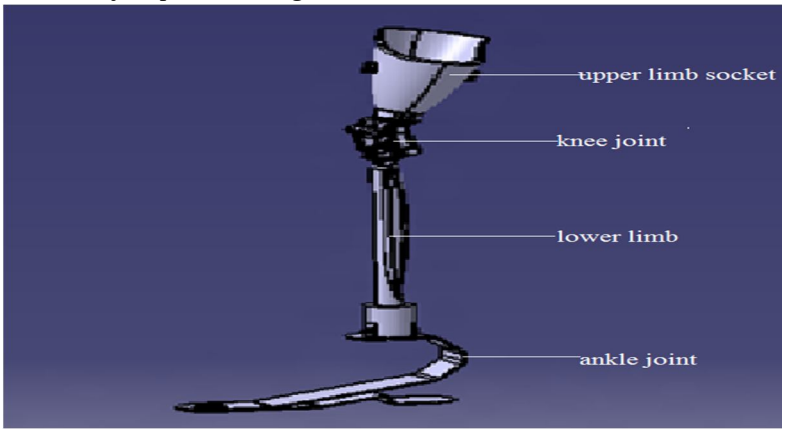


Fig. 5 Prosthetic leg Assemble

F. Prosthetic Leg Detailing

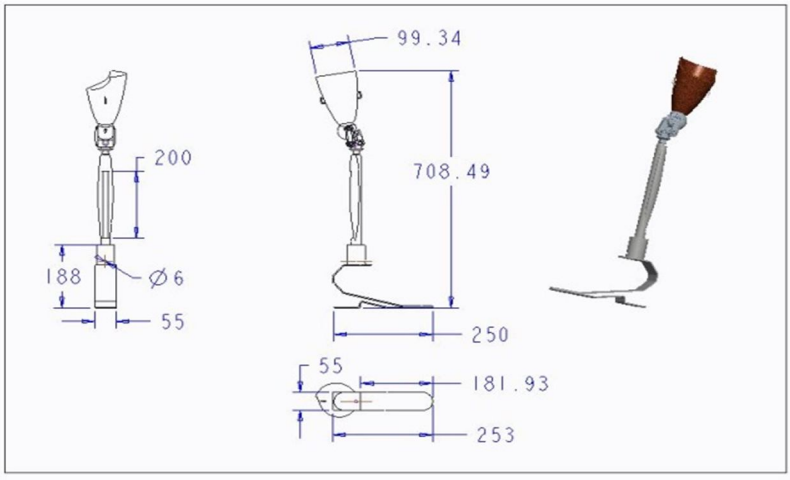
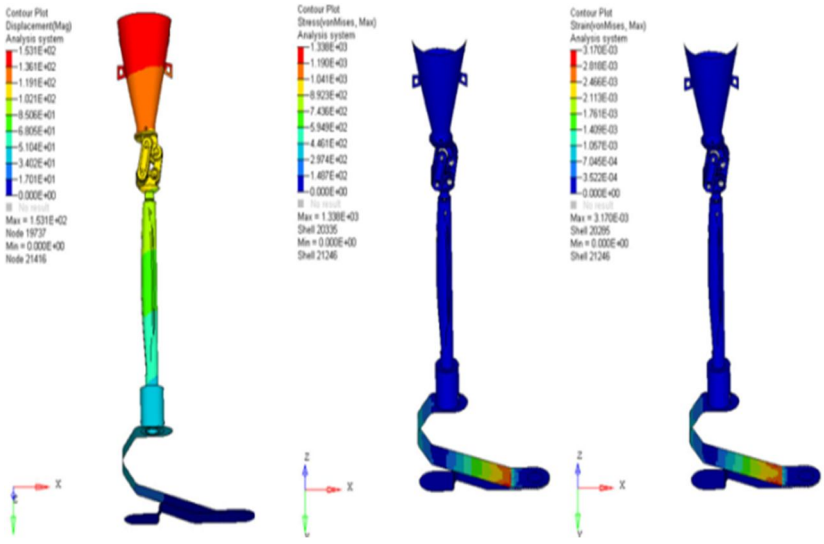


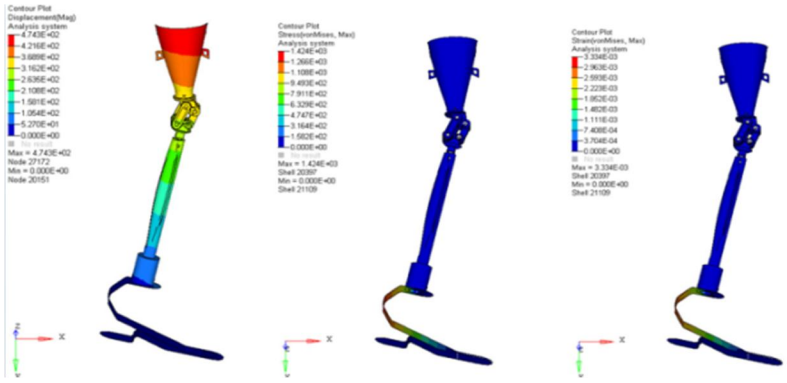
Fig. 6.Modified Prosthetic Leg Detailing

III. FEA ANALYSIS (STATIC)

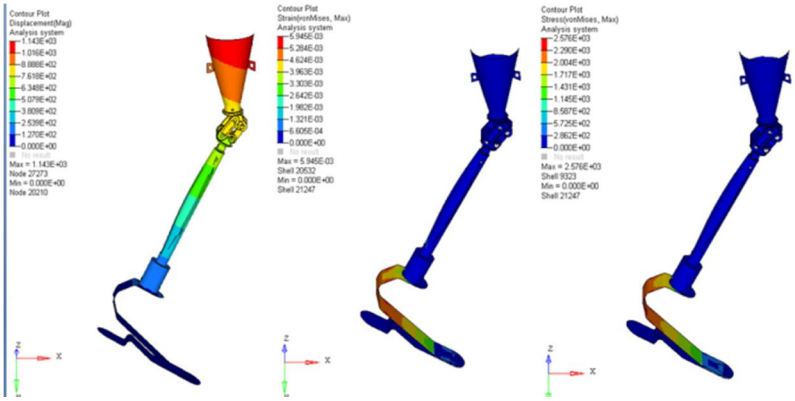
Prosthetic leg for 80 kg Straight (0 Degree) at 3-mm Thick Base Leg :-



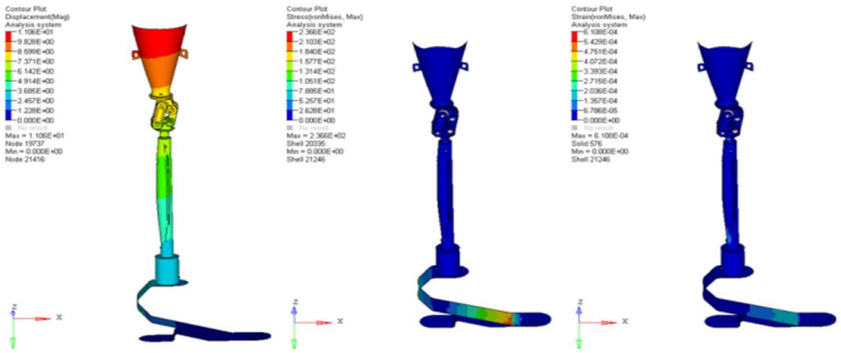
Prosthetic leg for 80 kg Backward (15 Degree) at 3-mm Thick Base Leg



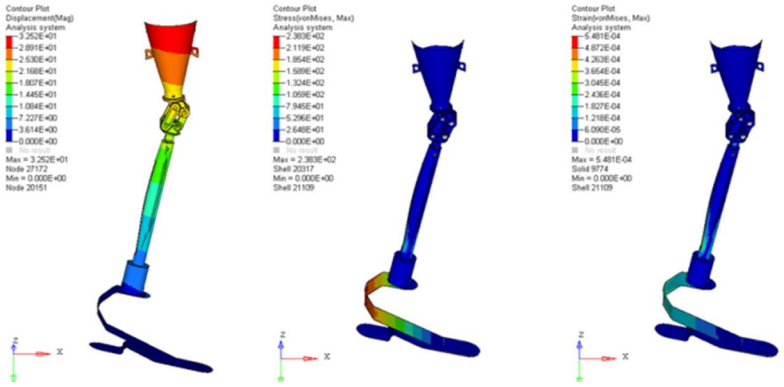
Prosthetic leg for 80 kg Backward (30 Degree) at 3-mm Thick Base Leg



Prosthetic leg for 80 kg Straight (0 Degree) at 7.5 -mm Thick Base Leg



Prosthetic leg for 80 kg Backward (15 Degree) at 7.5 -mm Thick Base Leg



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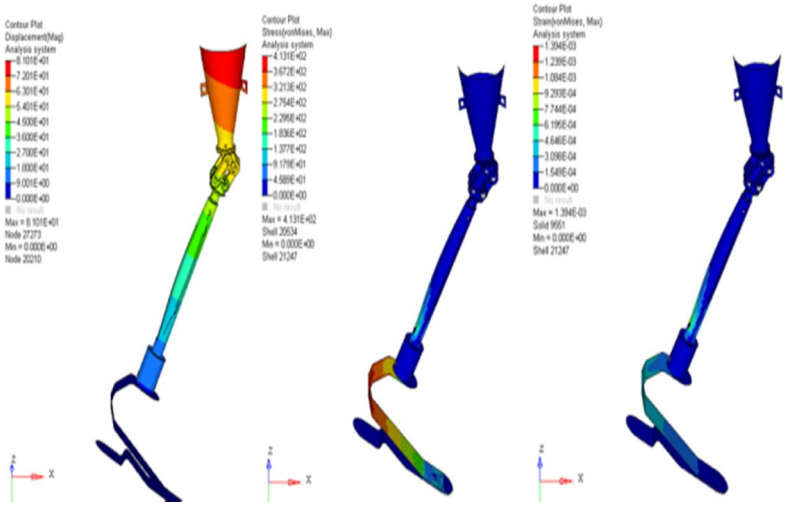
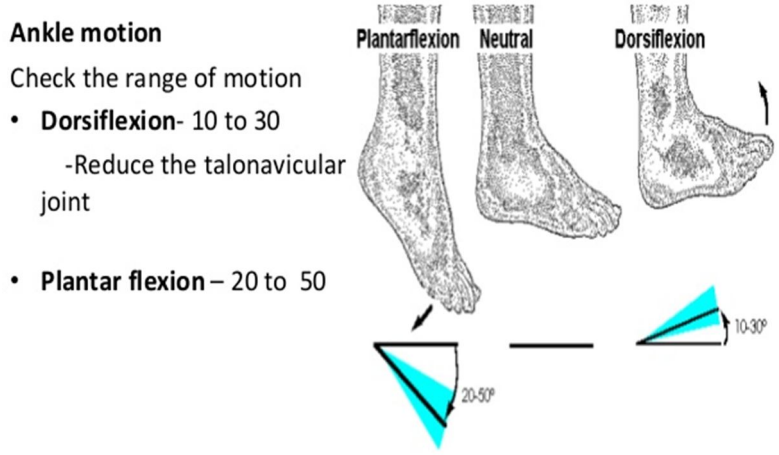
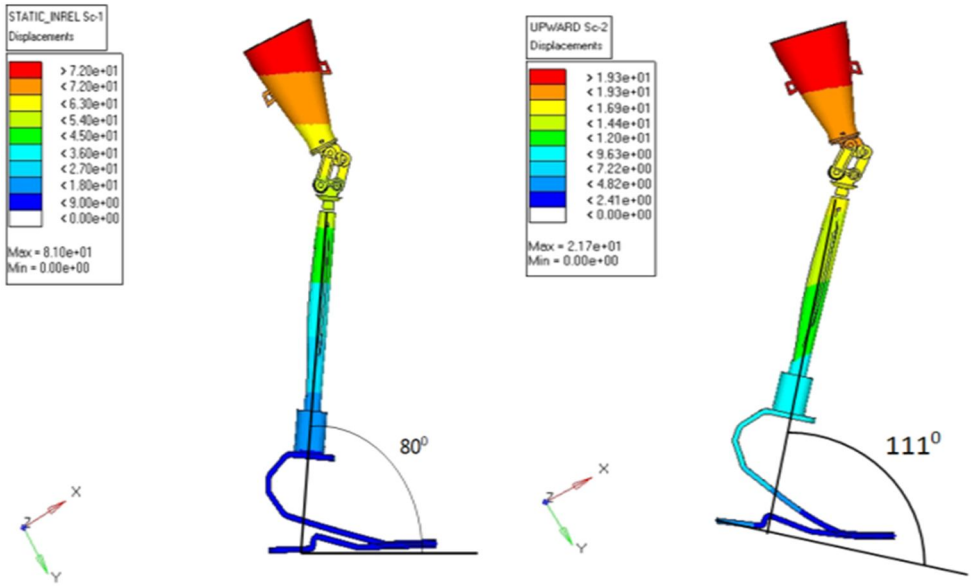
Prosthetic leg for 80 kg Backward (30 Degree) at 7.5 -mm Thick Base Leg



IV. HUMAN COMFORT AND CONSIDERATION



Deflection or the range of motion in modified prosthetic leg



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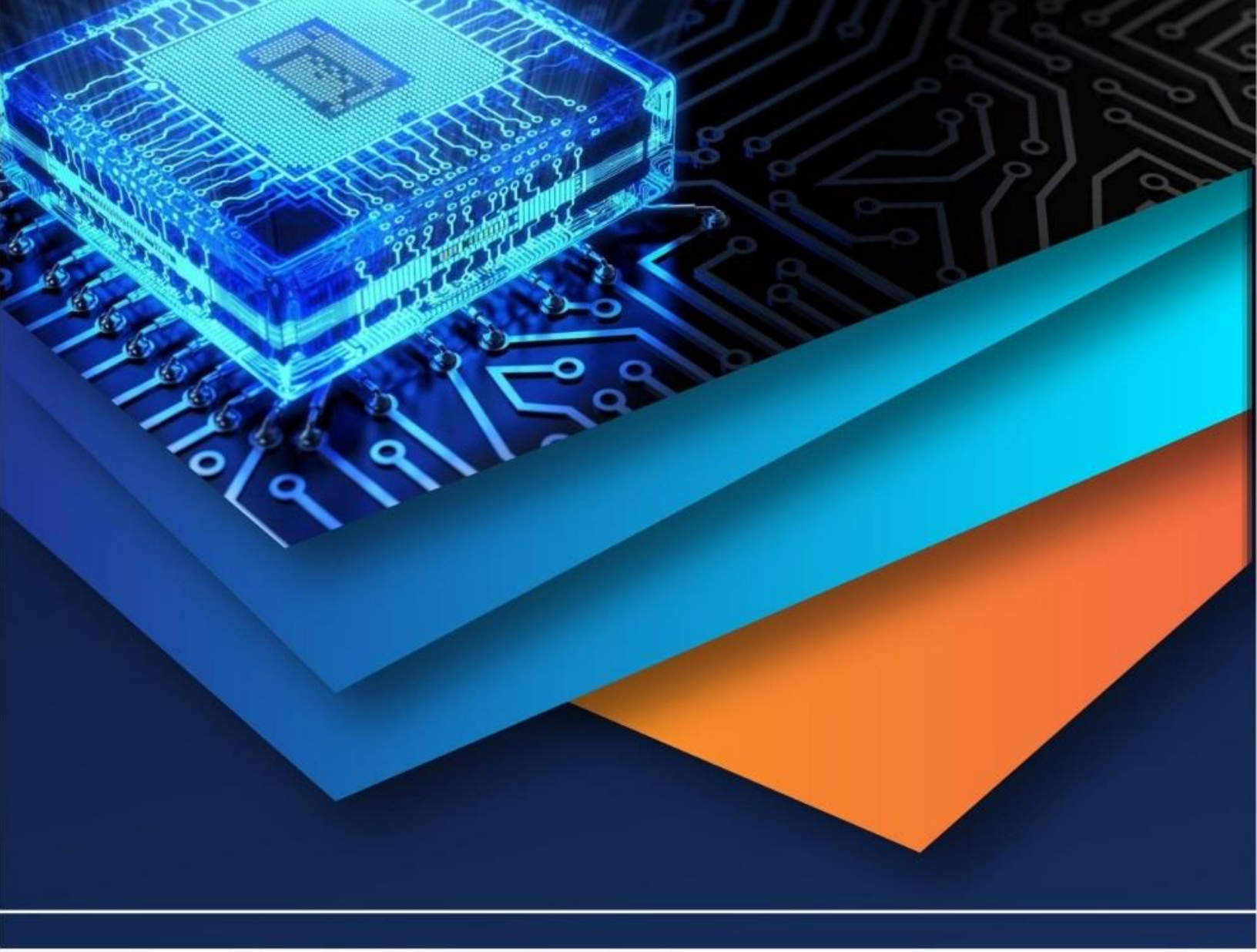

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