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DESIGN OF MICROSTRIP PATCH ANTENNA FOR 5G COMMUNICATIONS

M. Amrutha[1], A. Ritu Naga Sudha[2], G. Karthikeya[3], A V N S Sai Charan[4], B. Vamsi Singh[5], Mr. D. Venkanna Babu[6]

[6]Assistant Professor,[1,2,3,4,5] U.G Students, Department of Electronics and Communication Engineering,
Sri Vasavi Engineering College (Autonomous), Tadepalligudem, Andhra Pradesh, India

Abstract:

The Aim of this paper is to design a Micro-strip Patch Antenna for 5G Wireless Communications which works at 5G frequencies range with FR4 epoxy Dielectric Material. This work is designed and analysed for its Enhanced VSWR, Return Loss, Gain, Radiation Pattern in order to meet the requirements and to obtain best results for the 5G applications using HFSS.

Keywords: ***Microstrip Patch Antenna, Array antenna, FR4 Substrate, HFSS***

I. Introduction:

Traditional wireless network communication which is supporting around 100-200 Mbps have been revolutionized by 5G communication with a hike in the speed of data transfer up to 10-20gbps LAS-CDMA (Large Area Synchronized Code-Division Multiple Access), UWB, and other technologies support fifth-generation wireless communication. (Ultra-wideband). In order to get beyond the problems of multipath fading and inter-symbol interference, 5G utilises a larger bandwidth spectrum in the millimetre-wave range. It is ubiquitous access to high and low data rate services, habitually the antenna used in mobile communication systems is a static element which is used to improve the coverage, increasing the capacity, and decreasing the complexity of the networks. It aids in bridging any gaps in global connectivity. 5G can transfer both voice and high-speed data concurrently and more accurately. Low latency, which is required for live streaming, cloud gaming, etc., is one of the distinguishing characteristics of 5G. Globally these generations of wireless communication provide us 10X decline in the end- to-end latency. Because it can display doctors the patient's movements in real time, this can significantly improve the current user experience and open the door for brand-new capabilities like some of the services offered by ultra-low latency. To provide strong global coverage and versatility satellite communication conjointly accommodate the basic telecommunication requirements of many people across the country.

II. Antenna Design:

The key factors required to design an antenna are realizing the application to be accomplished and fulfil the requirements of the parameters. Undoubtedly, frequency plays a crucial role. Further, the operation of the antenna aids to determine the substrate to be used. After deciding the required data, then the physical dimensions have to be calculated. In this work, Rectangular micro strip patch array antenna is designed using Ansys High-Frequency Structure Simulator (HFSS) v 15.0 to design and simulate the antenna.

The antenna is designed by using the following dimensions of 15mm X 11mm having a thickness of 0.7mm at the substrate. The substrate is composed of FR4 epoxy with a relative permittivity of 4.4 and dielectric loss tangent of 0.02. Further, the patch having dimensions 2.59mmX3.65mm is etched onto the substrate. The port with dimensions 0.5mmX0.7mm. The geometric parameters are adjusted to observe the variations concerning the gain, bandwidth, and resonant frequency of the proposed antenna. The physical dimensions of the design are shown in Table 1 .

The top view of the proposed Rectangular micro strip patch array antenna is shown in figure-1:

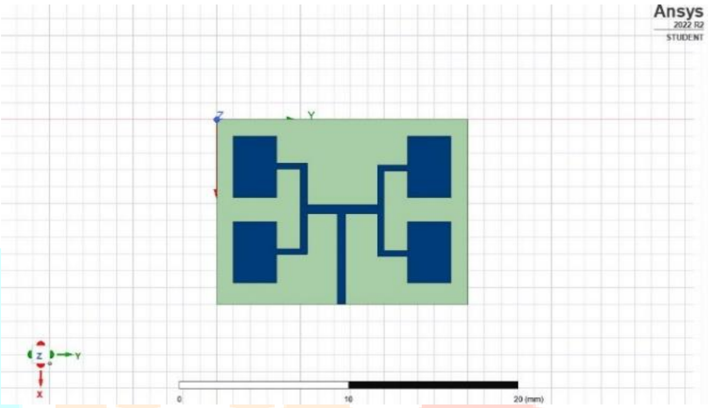

Figure-1: Rectangular micro strip patch array antenna

S.NO	NAME OF THE PARAMETER	UNIT (mm)
1.	Length of the substrate	15mm
2.	Width of the substrate	11mm
3.	Height of the substrate	0.7mm
4.	Length of the patch	3.65mm
5.	Width of the patch	2.59mm
6.	Length of the patch cutting	0.7mm
7.	Width of the patch cutting	0.668mm

Table-1 Dimensions of the patch antenna

III. Design stages of proposed antenna:

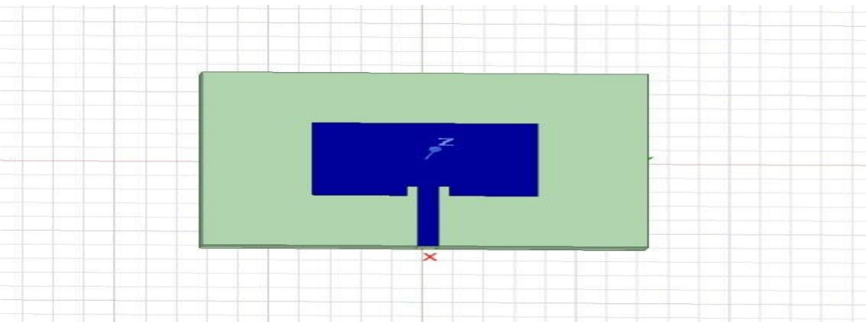

Figure-2: 1st iteration of proposed antenna

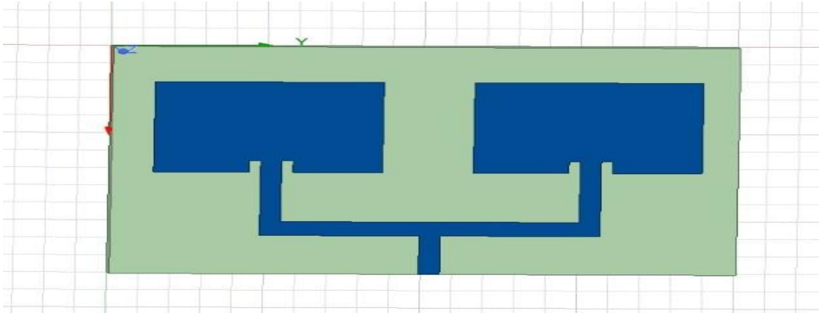

Figure-3: 2nd iteration of proposed antenna

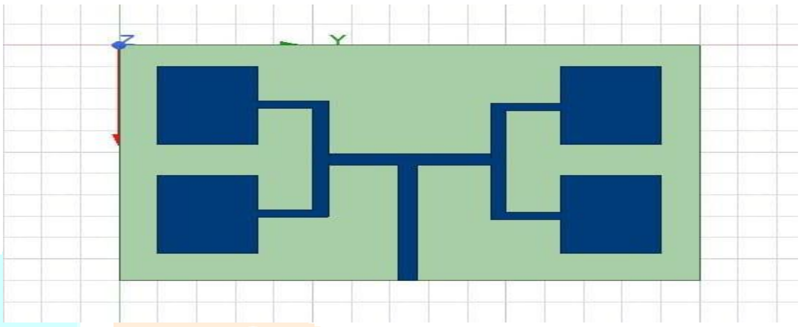

Figure-4: 3rd iteration of proposed antenna

IV. RSULTS:

The proposed antenna is designed with the resonant frequency 26.2 GHz using FR4 as a dielectric substrate.

Return Loss or S11 (S-Parameters):

The return loss of an antenna is a number that represents the percentage of radio waves that arrive at the antenna input that are rejected in comparison to those that are accepted. When impedance matching is crucial in RF circuits, return loss is a number that is frequently employed. The percentage of a signal that is reflected as a result of an impedance mismatch is known as the return loss.

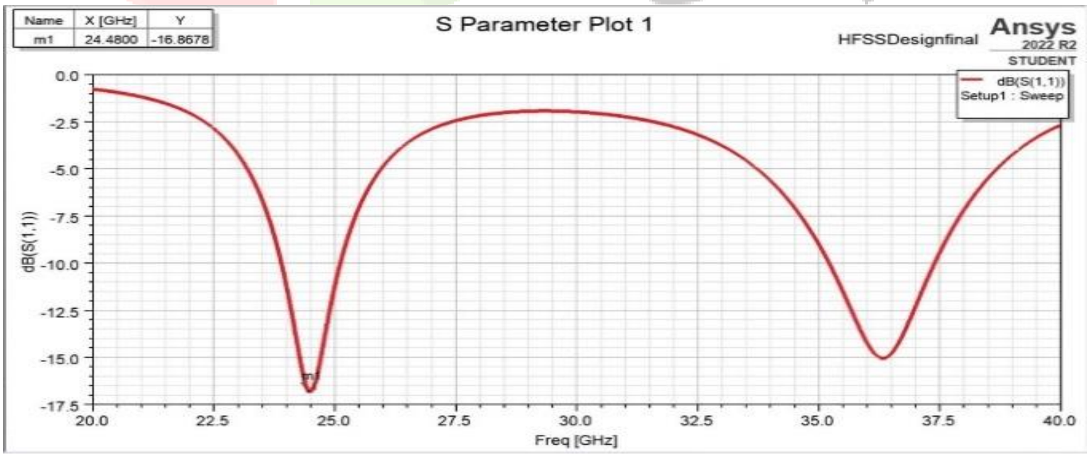

Figure-5: S-parameter plot of 1st iteration

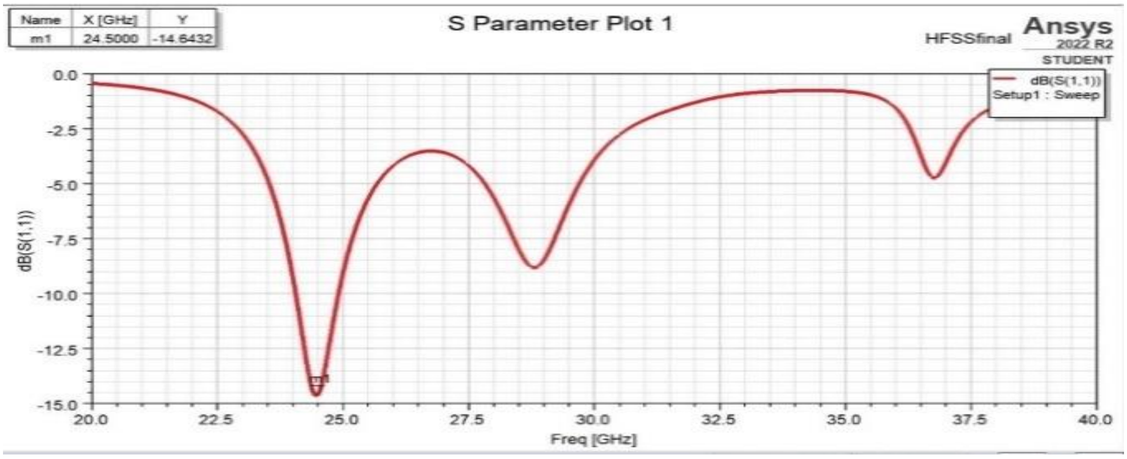

Figure-6: S-parameter plot of 2nd iteration

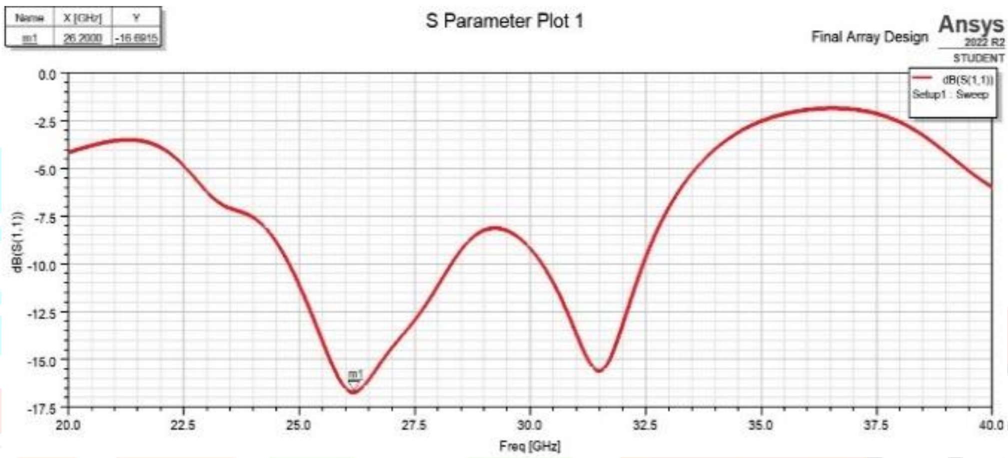

Figure-7: S-parameter plot of 3rd iteration

The figure 5, figure 6, figure 7 shows the S-parameters of the proposed antenna. It shows the S11 parameter of the 1st iteration is -16.8678dB, the S11 parameter of the 2nd iteration is -14.6432dB, the S11 parameter of 3rd iteration is
-16.6815dB.

Gain:

It specifies the proportion between the total input power supplied to the antenna and the output power emitted in a certain direction.
The ability of an antenna to emit more or less in any direction as compared to a theoretical antenna is known as antenna gain.

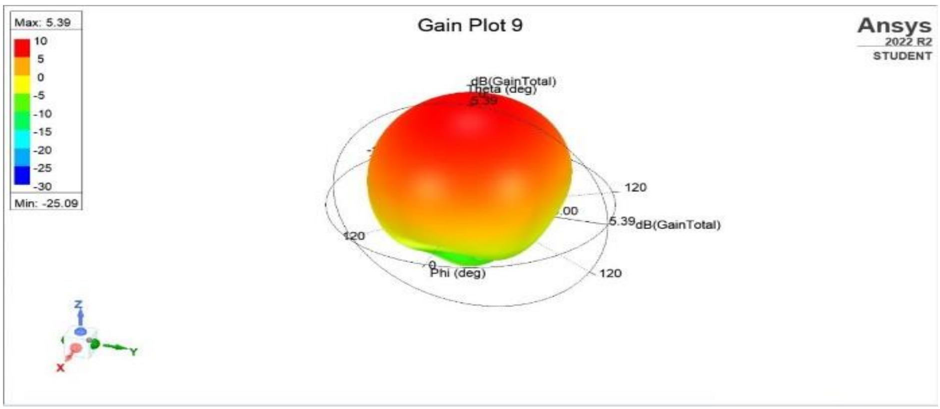

Figure-8: Gain plot of 1st iteration

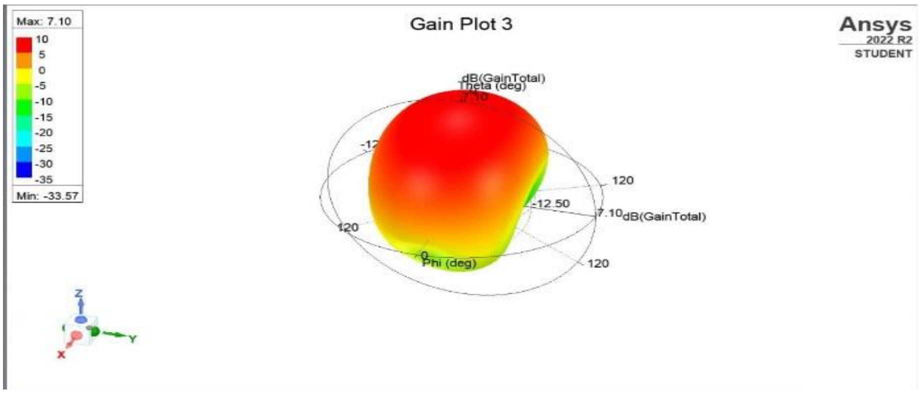

Figure-9: Gain plot of 2nd iteration

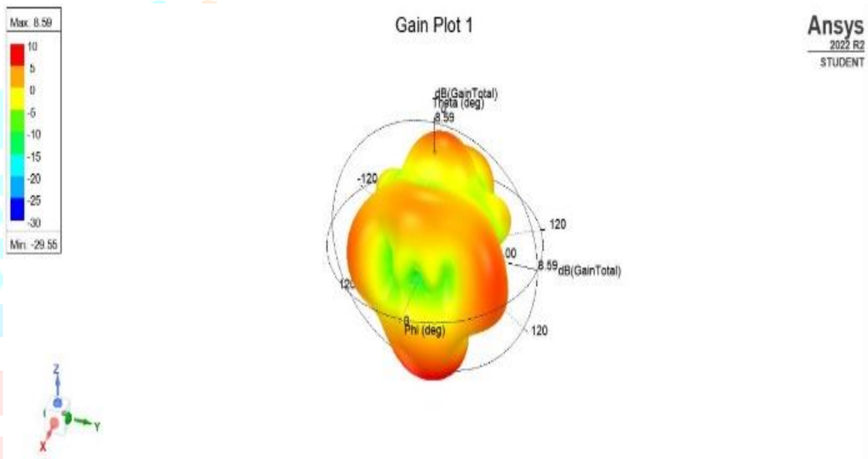

Figure-10: Gain plot of 3rd iteration

The figure 8, figure 9, figure 10 shows the gain shows the gain of the proposed antenna. It shows that the gain of the 1st iteration is 5.39dB, the gain of the 2nd iteration is 7.10dB, the gain of the 3rd iteration is 8.59dB.

VSWR:

Voltage Standing Wave Ratio is referred to as VSWR. The power reflected from the antenna, it says. The ratio of incident to reflected waves in an RF component or system is what is meant by this term. It establishes the effectiveness of power transmission along a transmission line from a source to a load. The VSWR's range spans from 1 to ∞. The best VSWR value for ultra-wide band applications is under 2.

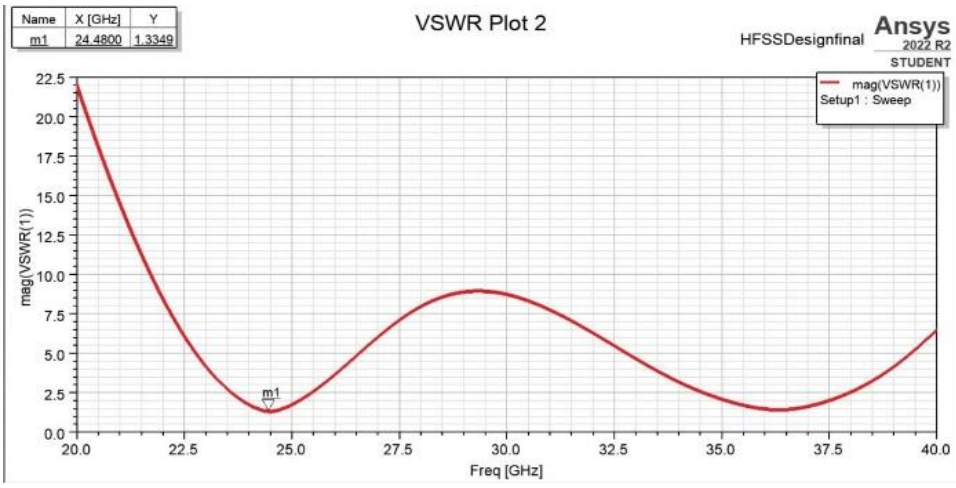

Figure-11: VSWR plot of 1st iteration

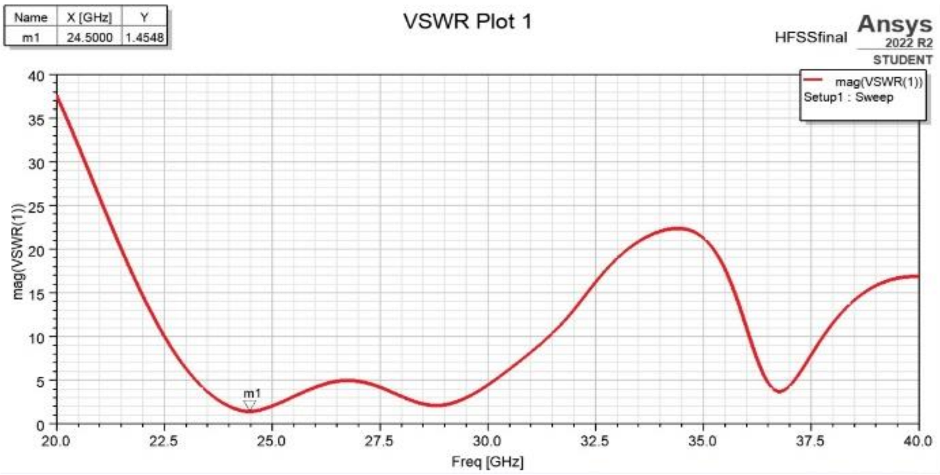

Figure-12: VSWR plot of 2nd iteration

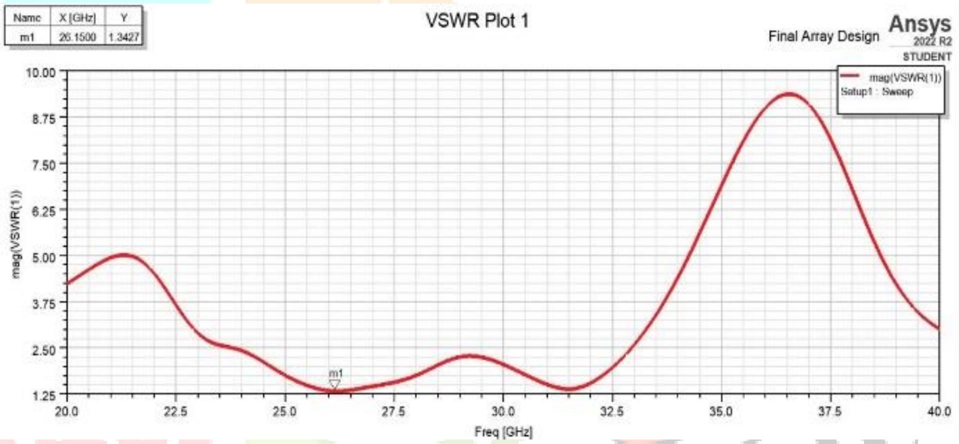

Figure-13: VSWR plot of 3rd iteration

The figure 11, 12 and13 shows the VSWR of the proposed antenna. It shows that VSWR of the 1st iteration is 1.33, the VSWR of the 2nd iteration is 1.4548, the VSWR of the 3rd iteration is 1.3427.

Radiation Pattern:

Diagrammatic representations of the distribution of radiated energy into space, as a function of direction, are known as radiation patterns. It is the gain's graphical representation.

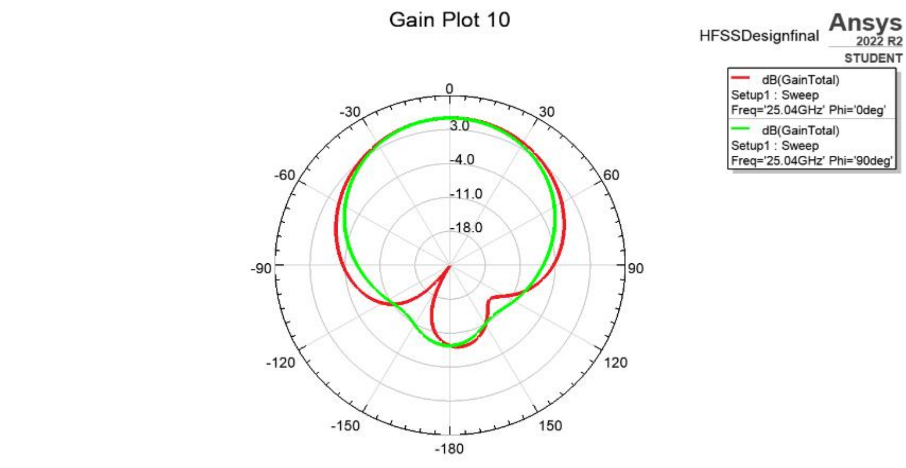

Figure-14: Radiation pattern of 1st iteration

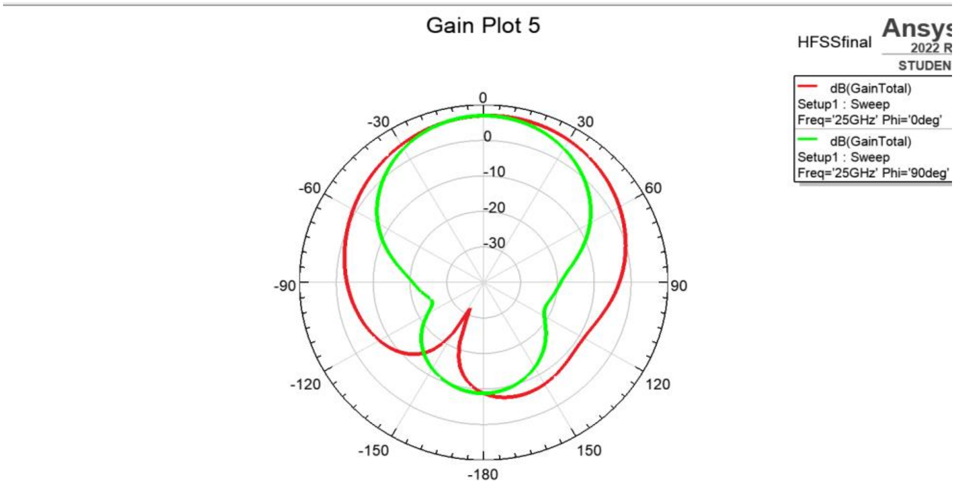

Figure-15: Radiation pattern of 2nd iteration

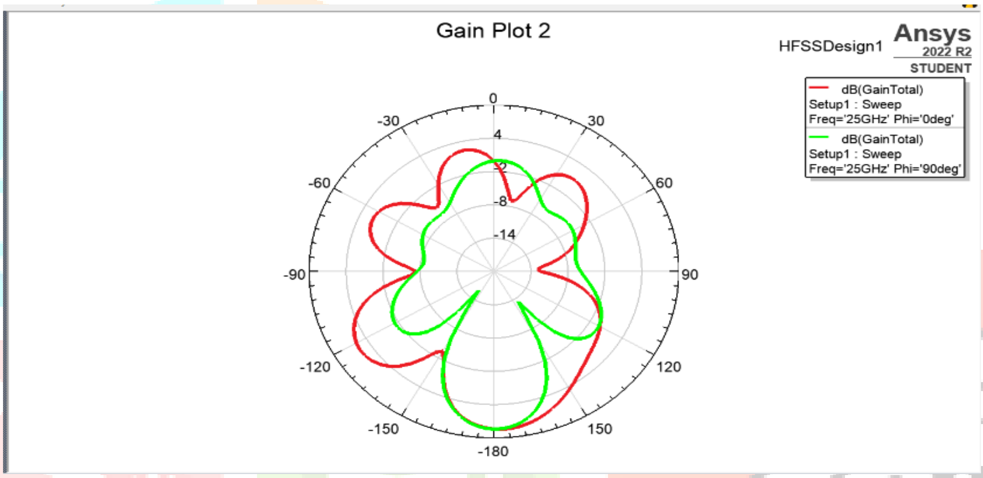

Figure-16: Radiation pattern of 3rd iteration

The figure 14, 15 and 16 shows the Radiation pattern of the proposed antenna.

V. COMPARISION TABLE:

parameter	**Single patch antenna**	**2nd iteration**	**3rd iteration**
S11	**-16.8678**	**-14.6432**	**-16.6815**
Gain	**5.39dB**	**7.10dB**	**8.59dB**
VSWR	**1.33**	**1.45**	**1.34**

The above table shows the comparison among the 3 iterations of the proposed antenna. We can notice that the S11 parameters of every iteration is below -10dB.The gain is enhanced for every iteration and the VSWR of every iteration is above 1.

VI. CONCLUSION:

The main aim of this paper is to enhance the gain for every iteration of the proposed antenna. It was observed that the S11 parameter of the 4^{th} iteration is -16.6815dB, the gain of the 4^{th} iteration is 8.59dB and the VSWR of the 4^{th} iteration is 1.3427. The maximum gain is obtained at the 4^{th} iteration by using array structure. The proposed antenna will be operated in 5G communications.

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