A Project Report on

DEAF ANTENNA FOR MM WAVE FILTER USING HFSS

submitted in partial fulfilment of the requirement for the award of degree of

BACHELOR OF TECHNOLOGY

in

ELECTRONICS AND COMMUNICATION ENGINEERING

Submitted by

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Regd.No:- 21P35A0419

Under the esteemed guidance of

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Professor

ADITYA COLLEGE OF ENGINEERING & TECHNOLOGY

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Aditya Nagar, ADB Road, Surampalem-533 437

(2023-2024)

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Department of Electronics and Communication Engineering

ENLIGHTENS THE NESCIENCE

CERTIFICATE

This is to certify that the project report entitled "**DEAF ANTENNA FOR MM WAVE FILTER USING HFSS"** is being submitted by **Rajana Sai Krishna (21P35A0419)** has been carried out in the partial fulfillment of the requirement for the award of the degree of **Bachelor of Technology** in **Electronics and Communication Engineering**, **Aditya College of Engineering & Technology**, Surampalem,affiliated to **JNTUK, Kakinada** is a record of bonafide work carried out by them under my guidance and supervision during the academic period 2023-2024.

Project Guide	**Head of the Department**
Dr. DOLA SANJAY S, M.Tech., Ph.D.	**Dr. R. V. V. KRISHNA, M. Tech., Ph.D.**
Professor & Principal	**Professor & HOD**
Aditya College of Engineering & Tech	**Dept. of ECE**

INTERNAL EXAMINER **EXTERNAL EXAMINER**

DECLARATION

We are hereby declaring that the entire project work embodied in this dissertation entitled "**DEAF ANTENNA FOR MM WAVE FILTER USING HFSS**" has been independently carried out by us. As per our knowledge, no part of this work has submitted for any degree in any institution, university and organization previously.

Yours sincerely,

Rajana Sai Krishna

21P35A0419

ACKNOWLEDGEMENT

It gives us immense pleasure to express a deep sense of gratitude to my guide **Dr. Dola Sanjay S**, **M.Tech., Ph.D** Professor, Department ECE for whole heartedand invaluable guidance throughout the project work. Without her sustained and sincere effort, this project work would not have taken this shape. She encouraged and helped us to overcome various difficulties that we have faced at various stages of our project work.

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We would like to take this opportunity to thank our beloved Principal **Dr. Dola Sanjay S**, **M.Tech., Ph.D** for providing all the necessary facilities and a great support to us in completing the project work.

We would like to thank **all the faculty members** and the **non-teaching staff** of the Department of Electronics and Communication Engineering for their direct or indirect support for helping us in completion of this project work.

Finally, we would like to thank all our **friends** and **family members** for their continuous help and encouragement.

Yours sincerely,
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- To disseminate knowledge through quality teaching learning process.

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PEO2: Graduates shall inculcate the urge to progress in the chosen field of Electronics & Communication through higher education and research.

PEO3: Graduates shall ingrain professional values through Ethics based teaching learning process.

PEO4: Graduates shall exhibit leader ship skills and advance towards Entrepreneurship, Innovation and lifelong learning.

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PROGRAM SPECIFIC OUTCOMES (PSOs)

Program Name: Bachelor of Technology (B.Tech) in Electronics & Communication Engineering

PSO1: Industry ready in the arena of electronics & communication, VLSI, Robotics, Embedded Systems, IOT and allied fields.

PSO2: Acquire the required ability and knowledge to design, test, verify and develop innovative electronics projects through theoretical and laboratory practice.

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PROGRAM OUTCOMES (POs)

PO1. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
.

PO2. **Problem Analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. **Design/Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6. **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

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PO10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, give and receive clear instructions.

PO11. **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. **Life-Long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

B. Tech 4/4, II-SEMESTER

Course Outcomes

Upon completion of the course, students will be able to:

CO#	Course Outcomes	Blooms Taxonomy level
CO1	Identify the problem by applying acquired knowledge.	Remember
CO2	Use literature to identify the objective, scope and the concept of the work.	Apply
CO3	Analyse and categorize executable project modules after considering risks.	Analyse
CO4	Choose efficient tools for designing project modules.	Evaluate
CO5	Integrate all the modules through effective team work after efficient testing.	Create
CO6	Explain the completed task and compile the project report.	Understand

CO-PO/PSO MATRIX:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	2	2	-	2	-	-	-	-	-	-	-	2	2
CO2	2	2	2	2	-	-	-	2	2	-	-	1	2	2
CO3	2	-	2	2	-	-	-	2	2	-	-	2	2	2
CO4	2	-	-	-	3	-	-	-	-	-	3	-	-	2
CO5	-	-	-	2	2	-	-	-	2	2	-	2	2	2
CO6	-	-	-	-	-	-	-	-	2	2	3	1	-	2
Course	2	2	2	2	2.5	-	-	2	2	2	3	1.5	2	2

Signature of the Guide

CO-PO Justification

CONo.	PO/PSO	CL	Justification
CO1	PO1	2	Moderately mapped as we need basic concepts of Antenna.
	PO2	2	Moderately mapped as we need to identify, analyze, and formulate different types of Antennas.
	PO3	2	Moderately mapped as we need to design solutions for problems on Antenna
	PO5	2	Moderately mapped as we need to apply modern tools to the activities related to Antenna.
	PSO1	2	Moderately mapped as we will be able to understand importance of in real time applications.
	PSO2	2	Moderately mapped as we will need equipped laboratory infrastructure
CO2	PO1	2	Moderately mapped as we need to apply HFSS software techniques For the analysis of Antenna Design.
	PO2	2	Moderately mapped as we need to analyze problems related to Antenna.
	PO3	2	Moderately mapped as we will be able to find the solution for the problem identified.
	PO4	2	Moderately mapped as we will be able to investigate the complex problems in the project.
	PO8	2	Moderately mapped as we need to have the basic idea about the rules to be followed.
	PO9	2	Moderately mapped as we need to work together to study the tools and technologies.
	PSO1	2	Moderately mapped as we need to have to train ourselves industry ready in the field of electronics and communication
	PSO2	2	Moderately mapped as we will need equipped laboratory infrastructure
CO3	PO1	2	Moderately mapped as we should know about Antenna design techniques.
	PO3	2	Moderately mapped as we need design complex solutions related to Antenna realization.
	PO4	2	Moderately mapped as we will be able to investigate the complex problems in the project.
	PO8	2	Moderately mapped as we need to have the basic idea about the rules to be followed.
	PO9	2	Moderately mapped as we need to work together to study the tools and technologies.

	PSO1	2	Moderately mapped as we need to have the basic idea about Antenna practical application.
	PSO2	2	Moderately mapped as we will need equipped laboratory infrastructure
CO4	PO1	2	Moderately mapped as we need to have basic knowledge of Antenna Design.
	PO5	3	Highly mapped as we need to know tools used related to Antenna design.
	PO11	3	Highly mapped as the students will be able to manage the financial constraints.
	PSO2	2	Moderately mapped as we need to have the basic idea about Antenna design in practical application.
CO5	PO4	2	Moderately mapped as we need to design an Antenna.
	PO5	2	Moderately mapped as we should know about modern tools used to for better Antenna design.
	PO9	2	Moderately mapped as we need to identify the risks involved in the project and its effecton society.
	PO10	2	It is moderately mapped as the we will be able to communicate their work in reviews and paper presentations.
	PSO1	2	Moderately mapped as we need to have to train ourselves industry ready in the field of electronics and communication
	PSO2	2	Moderately mapped as we need to have the basic idea about Antenna design in practical application.
CO6	PO9	2	Moderately mapped as we need to work together to make the project better understandable.
	PO10	2	Moderately mapped as we need to have the basic idea about Antenna design in practical application
	PO11	3	Highly mapped as team need to work on project management.
	PSO2	2	Moderately mapped as we need to have the basic idea about Antenna design in practical application.

Signature of the Guide

Abstract

With the advancement in communication technology over the past decade, there is an increasing demand for miniaturization and cost. To overcome this problem, we have microstrip antenna designs which can support meeting these requirements. The proposed design is employed with two radiating elements with slits in the radiators to produce high isolation and maintains a structure of 11.4 x 6.3 mm^2 which operates at a frequency of 29 GHz. The Line feed is used to provide an electrical signal to the patch of the antenna. Rogers 4350B substrate is used to design the proposed geometry because it is an ideal material for circuits that requires high signal integrity, low loss and better performance characteristics. The dielectric constant of the Rogers 4350B substrate is 3.36 with a height of 0.8mm. The designed antenna parameters are validated using simulation software Ansoft High-Frequency Structure Simulator (HFSS). The performance parameters like S-Parameters, VSWR, return loss, ECC, Diversity Gain and Gain are observed. The designed antenna is useful for 5G applications.

Keywords: High-Frequency Structure Simulator (HFSS), Dual Element Adaptive Frequency Antenna (DEAF), 5G Applications.

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CHAPTER 1

1.1 Introduction:

Communication is a method of transmitting information from one place toanother place. Based on transmission media, there are two types of communication system. These are wired and wireless. Guided media (wired), refers to the transmissionof the information over a wire-based communication technology include twisted-pair cable, coaxial cable, and fiber-optic cable. Of those wired Media's fiber optic is the most efficient because it has large bandwidth, more reliable, and higher flexibility. In wireless media, information is transmitted by radiating a modulated electromagnetic wave at a certain carrier frequency by means of a transmitter antenna and picking up energy of the radiated wave by means of a receiver antenna.

1.2 Thesis Motivation:

The aim is to overcome the low performance and design complexity of microstrip patch antenna for 5G mobile communication networks. An easy to fabricate microstrip patch antenna is proposed here, having a rectangular radiating patch over a Rogers 4530 substrate, due to its low dielectric constant and low loss dispersion, which is considered as a suitable material for ultrahigh frequency (UHF). The required gain and radiation pattern for mobile communication is achieved by using patch structure. Due to the rapid growth of communication system connected devices, current 4G technology will not meet the recent demand. Therefore, the mobile communication system must be upgraded to the next generation (5G) in order to meet the future demand of high data rates. Research is underway for 5G mobile communications and is expected to be commercialized early in the 21st century.

1.3 The Development of Mobile Phone Generations:

1st Generation:

In the first generation 1G of mobile system, the system was operating at 800 MHz and as known it was analogy. The first antenna handset for one quarter of wavelength has length about 9.4 cm, and it was one antenna only with the improvement on mobile phone and due to the dramatic minimizing size of the mobile phone, there were no needs for a sleeve dipole to be proportional to the cellular phone.

Fig 1.1: 1G Mobile

Features of 1G:

- Developed in 1980s & completed in early 1990s
- Based on analog system
- Speed up to 2.4 kbps
- AMPS (Advance Mobile Phone System) was launched by the US
- Allows user to make voice calls in 1 country

2nd Generation:

In comparison to 1G's analog signals, 2G's digital signals are very reliant of location and proximity. If a 2G handset made a call far away from a cell tower, the digital signal may not be enough to reach it. While a call made from a 1G handset had generally poor quality than that of a 2G handset, it survived longer distances. This is due to the analog signal having a smooth curve compared to the digital signal, which had a jagged, angular curve. As conditions worsen, the quality of a call made from a 1G handset would gradually worsen, but a call made from a 2G handset would fail completely.

Fig 1.2: 2G Mobile

Features of 2G:

- Developed in late 1980s & completed in late 1990s
- Based on digital system
- Speed up to 64 kbps
- Services such are digital voice & SMS with more clarity
- Semi global facility

3rd Generation:

International Mobile Telecommunications-2000 (IMT--2000), better known as 3G or 3rd Generation, is a generation of standards for mobile phones and mobile telecommunications services fulfilling specifications by the International Telecommunication Union. The use of 3G technology is also able to transmit packet switch data efficiently at better and increased bandwidth. 3G mobile technologies proffers more advanced services to mobile users. The spectral efficiency of 3G technology is better than 2G technologies. Spectral efficiency is the measurement of rate of information transfer over any communication system. 3G is also known as IMT-2000.

Fig 1.3: 3G Mobile

Features of 3G:

- Transmission speed from 125 kbps to 2 Mbps
- Superior voice quality
- Good clarity in video conference
- Data are sent through technology called packet switching
- Voice calls are interpreted using circuit switching

4th Generation:

4G refers to the fourth generation of cellular wireless standards. It is a successor to 3G and 2G families of standards. The fourth generation (4G) is a conceptual framework and a discussion point to address future needs of a high speed wireless network that can transmit multimedia and data to and interface with wire-line backbone network perfectly just raised in 2002. The speeds of 4G can theoretically be promised up to 1Gbps.

Fig 1.4: 4G Mobile

Applications of 4G:

- Mobile TV – a provider redirects a TV channel directly to thesubscriber's phone where it can be watched.
- Video on demand – a provider sends a movie to the subscriber's phone.
- Video conferencing – subscribers can see as well as talk to each other
- Tele-medicine – a medical provider monitors or provides advice to the potentially isolated subscriber.
- Mobile WiMAX (Worldwide Interoperability for Microwave Access).

Disadvantages of 4G Technology:

- Limited Use of Internet and Smartphone.
- Battery Consumption.
- Limited 4G network towers.
- Cost of Phone.
- Higher data consumption.

5th generation:

5G Technology stands for 5th Generation Mobile technology. 5G technology has changed the means to use cell phones within very high bandwidth. User never experienced ever before such a high value technology. The 5G technologies include all type of advanced features which makes 5G technology most powerful and in huge demand in near future. A user can also hook their 5G technology cell phone with their laptop to get broadband internet access. 5G technology including camera, MP3 recording, video player, large phone memory, dialing speed, audio player and much more you never imagine.

Advantages of 5G:

- High-Speed Data: 5G networks deliver significantly faster data speeds compared to 4G LTE, enabling quicker downloads and smoother streaming.
- Increased Capacity: 5G can support a vast number of connected devices simultaneously, crucial for the growing Internet of Things (IoT) ecosystem.
- Low Latency: With reduced latency, 5G enables near-instantaneous communication between devices, enhancing experiences like gaming andvideo calling.
- Support for Emerging Tech: From augmented reality to autonomous vehicles, 5G provides the speed and reliability needed for next-gen technologies.
- Economic Impact: Deployment of 5G networks stimulates economic growth, fosters innovation, and creates new opportunities across industries.

Fig 1.5: 5G Mobile

5G Applications in Real world:

- With high capacity and ultra-low latency, 5G will give artificial intelligence (AI) and IoT applications a major boost across a range ofindustries and use cases.
- Consumers will see changes including more immersive gaming andimproved retail experiences.
- As enterprises use 5G as a conduit to process and analyze more data, business value is expected to be generated across a range of industries.

1.4 Types of Antennas:

Based on a physical structure, the different types of antennas are Wire antennas, Aperture antennas, Reflector antennas, Quarter-wave patch antenna, Array antennas, Lens antennas, Travelling-wave antenna, long periodic antenna and Micro strip patch antennas.

Wire Antenna:

Wire antennas are one of the simplest and commonly used antennas. They can be found in vehicles (automobiles), ships, aircrafts, buildings etc. wire antennas come indifferent shapes and sizes like straight wire (dipole), loop and helix.

Aperture Antenna:

A class of directional antennas. aperture antennas have an opening in the surface. Usually, aperture antennas consist of a dipole or a loop antenna in a guiding structure with opening to emit radio waves. Antennas of this type are very useful for aircraft and spacecraft applications, because they can be very conveniently flush-mounted on the skin of the aircraft or spacecraft. In addition, they can be covered with a dielectric material to protect them from hazardous conditions of the environment. There are different types of aperture antennas some of them are slot antenna and horn antenna.

Reflector Antenna:

The success in the exploration of outer space has resulted in the advancement of antenna theory. Because of the need to communicate over great distances, sophisticated forms of antennas had to be used in order to transmit and receive signals that had to travel millions of miles. A very common antenna form for such an application is a parabolic reflector. Antennas of this type have been built with diameters as large as 305m.

Such large dimensions are needed to achieve the high gain required to transmit or receive signals after millions of miles of travel. Another form of a reflector, although not as common as the parabolic, is the corner reflector.

Array Antenna:

Many applications require radiation characteristics that may not be achievable by a single element. It may, however, be possible that an aggregate of radiating elements in an electrical and geometrical arrangement (an array) will result in the desired radiation characteristics. The arrangement of the array may be such that the radiation from the elements adds up to give a radiation maximum in a particular direction or directions, minimum in others, or otherwise as desired. Usually, the term array is reserved for an arrangement in which the individual radiators are separate by the minimum acceptable distance. However, the same term is also used to describe an assembly of radiators mounted on a continuous structure.

Lens Antennas:

Lenses are primarily used to collimate incident divergent energy to prevent it from spreading in undesired directions. By properly shaping the geometrical configuration and choosing the appropriate material of the lenses, they can transform various forms of divergent energy into plane waves. They can be used in most of the same applications as are the parabolic reflectors, especially at higher frequencies. Their dimensions and weight become exceedingly large at lower frequencies. Lens antennas are classified according to the material from which they are constructed, or according to their geometrical shape. In summary, an ideal antenna is one that will radiate all the power delivered to it from the transmitter in a desired direction or directions. In practice, however, such ideal performances cannot be achieved but may be closely approached. Various types of antennas are available and each type can take different forms in order to achieve the desired radiation characteristics for the particular application.

Patch Antenna:

The micro strip antenna is generally a single-layer design and consists of a radiating metallic patch or an array of patches situated on one side of a thin, non-conducting, substrate panel with a metallic ground plane situated on the other side of the panel. they are described by Howell in1972, the two metal sheets form a resonant piece of micro strip transmission time with a length of approximation one half of the wavelength the radio wave. One of the most micro strip antennas is rectangular patch antenna and its return loss is large as compared with the circular patch antenna. The length the micro strip transmission line slightly shorter than one half of the wavelength at frequency is used and the performance of patch depends on its size and shape.

MIMO Antenna:

MIMO stands for Multiple Input Multiple Output. It's a technology used in wireless communication systems to enhance performance by transmitting and receiving multipledata streams simultaneously over the same radio channel. In MIMO systems, multipleantennas are used both at the transmitter and receiver ends. These antennas work together to improve the reliability and throughput of wireless communication. MIMO takes advantage of multipath propagation, where signals reflect off surfaces and arriveat the receiver via different paths, by using spatial diversity.

1.5 MIMO Antenna for 5G Communication:

MIMO technology plays a crucial role in 5G communication systems, enabling higher data rates, increased network capacity, and improved reliability. In 5G, MIMO antennas are designed to operate across a wide range of frequencies, including both sub-6 GHz and mm Wave bands.

Here are some key aspects of MIMO antennas for 5G communication:

1. Massive MIMO: 5G networks often deploy massive MIMO systems, which utilize many antennas at both the base station (BS) and user equipment (UE) sides. Massive MIMO can support dozens or even hundreds of antennas, allowing for significant spatial multiplexing gains and interference mitigation.
2. Beamforming: MIMO antennas in 5G systems leverage advanced beamforming techniques to focus radio energy in specific directions, enhancing coverage, and improving signal quality. Beamforming can be implemented using both analog and digital techniques.
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1.6 Introduction to HFSS:

Since performance of electronic devices depends on electromagnetic (EM) Behavior, you need a fast, accurate account of how your design will behave in real-world implementations long before any prototype is built. ANSYS HFSS simulation results give you the confidence you need: The technology delivers the most accurate possible answers with the least amount of user involvement. As the reference-standard simulation tool for 3-D full-wave electromagnetic-field simulation, HFSS is essential for designing high-frequency and/or high-speed components used in modernelectronics devices. The power behind HFSS lies in the mathematics of the finite element method (FEM) and the integral, proven automatic adaptive meshing technique.

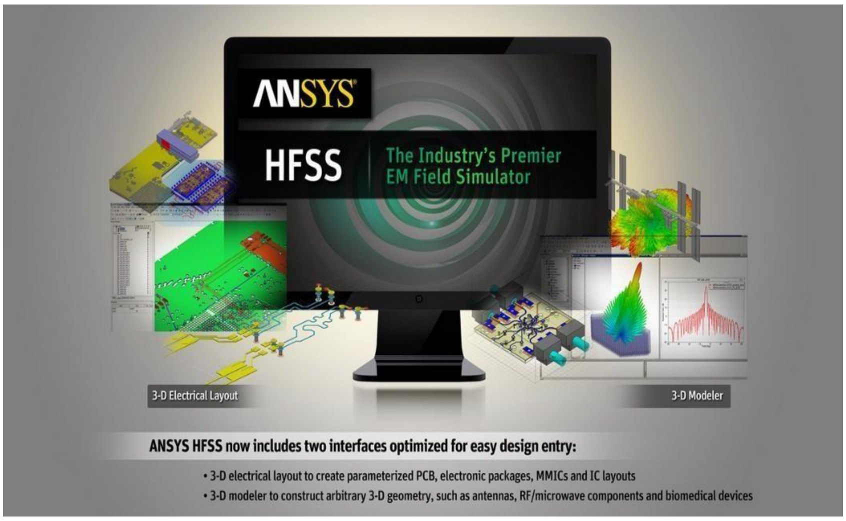


Fig 1.6: About HFSS

This provides a mesh that is conformation to the 3-D structure and appropriate for the electromagnetic problem you are solving. With HFSS, the physics defines the mesh. the mesh does not define the physics. As a result, you can focus on design issuesrather than spend significant time determining and creating the best mesh. HFSS benefits from multiple state-of- the-art solver technologies, allowing users to matchthe appropriate solver to any simulation need. HFSS (High Frequency Structure Simulator) is a powerful electromagnetic simulation software developed by Ansys, a leading provider of engineering simulation solutions. It's primarily used for simulating and analyzing high-frequency electromagnetic fields in complex structures. HFSS employs the Finite Element Method (FEM) to solve Maxwell's equations for electromagnetic fields, allowing engineers and researchers to predict the behavior of antennas, microwave circuits, high-speed interconnects, RF components, and other electromagnetic devices.

Key Features of HFSS Include:

1. 3D Modeling: HFSS allows users to create detailed 3D models of their designs, including complex geometries and material properties.
2. Solver Technology: The software employs advanced numerical techniques to accurately solve Maxwell's equations, including finite element, finitedifference, and integral equation methods.
3. Parametric Analysis: HFSS enables users to perform parametric studies to explore how design parameters affect the performance of their devices.
4. Antenna Design: It's widely used for designing and optimizing various types of antennas, including patch antennas, dipole antennas, horn antennas, and array antennas.
5. Microwave Circuits: HFSS can simulate microwave circuits like filters, couplers, power dividers, and amplifiers, helping engineers design and optimize their performance.
6. High-Speed Interconnects: It's also used for simulating signal integrity and electromagnetic interference (EMI) effects in high-speed interconnects such as printed circuit boards (PCBs) and connectors.
7. Integration with Other Ansys Tools: HFSS seamlessly integrates with other Ansys simulation tools such as SI wave for signal integrity analysis, Maxwell for low-frequency electromagnetic simulation, and Mechanical for structural analysis, allowing for multi-physics simulations.

1.7 System Integration:

Integration with the ANSYS Workbench platform enables you to simulate thermal- and fluid-based problems that require input from HFSS. Furthermore, HFSS forms an integral partof a system solution that involves circuit and components. You can analyze components with HFSS and then merge them into a circuit. The processleads to a unique system simulation.

1.8 HFSS Software Technical Setup Details:

a) Software size: 689byte
b) Installation full name: HFSS 15.0
c) Setup file name: HFSS_15.0.iso
d) Full set up: off line/online installer
e) Compatibility architecture: 32bit/64bit

1.9 Design Window:

- In the Ansoft HFSS Desktop, each project can have multiple designs and each design is displayed in a separate window.
- You can have multiple projects and design windows open at the same time.Also, you can have multiple views of the same design visible at the same time.
- To arrange the windows, you can drag them by the title bar, and resize them by dragging a corner or border. Also, you can select one of the following menu option**s:**

  Window >Cascade, Window >Tile Vertically, or Window > Tile Horizontally
- To organize your Ansoft HFSS window, you can iconize open designs. An Icon appears in the lower part of the Ansoft HFSS window. If the icon is not visible, it may be behind another open document. Resize any open documents as necessary. Select the menu item **Window > Arrange Icons** to arrange them at the bottom of the Ansoft HFSS window.
- Select the menu item **Window > Close All** to close all open design. You are prompted to **Save** unsaved designs.

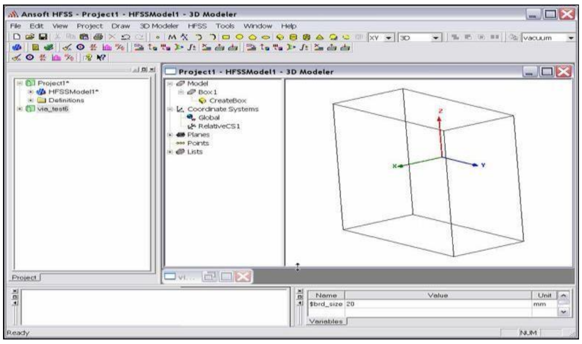


Fig 1.7: 3D Modular Window

1.10 Tool Bar:

The toolbars are the shortcuts for frequently used commands. Most of the available toolbars are displayed in this illustration of the ANSOFT HFSS initial screen, but your ANSOFT HFSS will not be probably will not be arranged in this way. You can customize your toolbar display in a way that is Convenient for you.

Some toolbars are displayed, other toolbars displayed when you select a document of the related type. When you select a 2D from the project tree, the 2D toolbar report display.

1.11 Set Solution Type:

This section describes how to set the solution type. The solution type defines thetype of results, how the excitations are defined, and the convergence. The following solution types are available

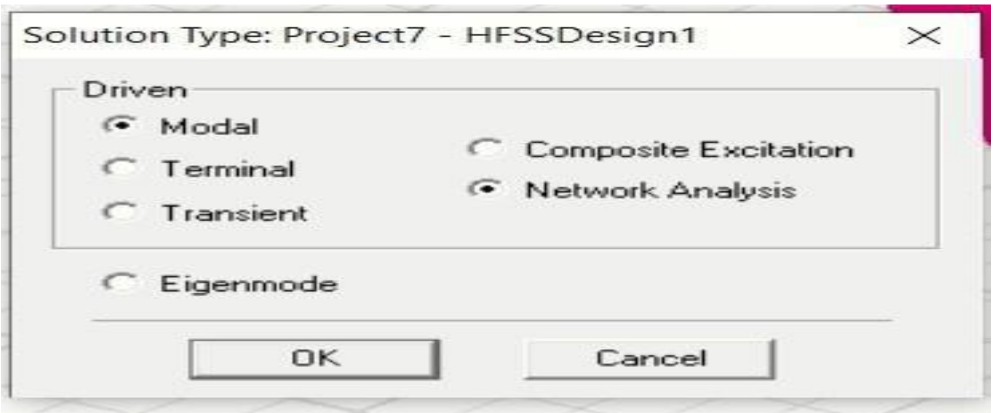
1. **Driven Model:** calculates the modal-based S-parameters. The S-matrix solutions will be expressed in terms of the incident and reflected powers of waveguide modes. The S-matrix will be expressed in terms of terminalvoltages and currents.
2. **Eigen Mode:** Calculate the eigen modes, or resonances, of a structure. The Eigenmode solver finds the resonant frequencies of the structure and the fields at thoseresonant frequencies.
3. 

Fig 1.9: Solution Type

1.12 Opening a HFSS Project:

1. Opening a new project
2. In ANSOFT HFSS window, select the menu item **File > New**
3. Select the menu **Project >Insert HFSS Design**.
4. Opening an Existing HFSS Project
5. In an ANSOFT HFSS window, select the **File>Open.**
6. Use the open dialog to select the project.
7. Click **Open** to open the project

1.13 Opening an Existing Project From Explorer:

- You can open a project directly from the Microsoft windows explorer.
- To open a project from windows Explorer, do one the following:
- Double-click on the name of the project in windows Explorer.
- Right-click the name of the project in windows Explorer and select openfrom the shortcut menu.

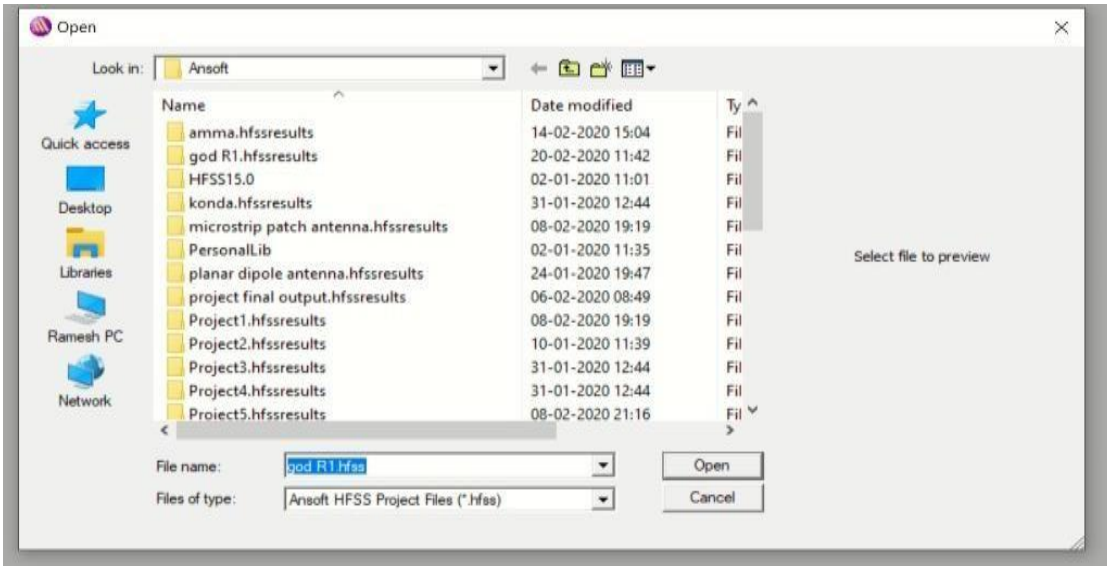


Fig 1.10: Opening a existing project for explorer

1.14 Parametric Model Creation:

➢ The Ansoft HFSS 3D Modeler is designed for ease of use and flexibility. The power of the 3D Modeler is in its unique ability to create fully parametric designswithout editing complex macros/model history.

➢ The purpose of this chapter is to provide an overview of the 3D Modeling capabilities. By understanding the basic concepts outlined here you will be able to quickly take advantage of the full feature set offered by the 3D Parametric Modeler.

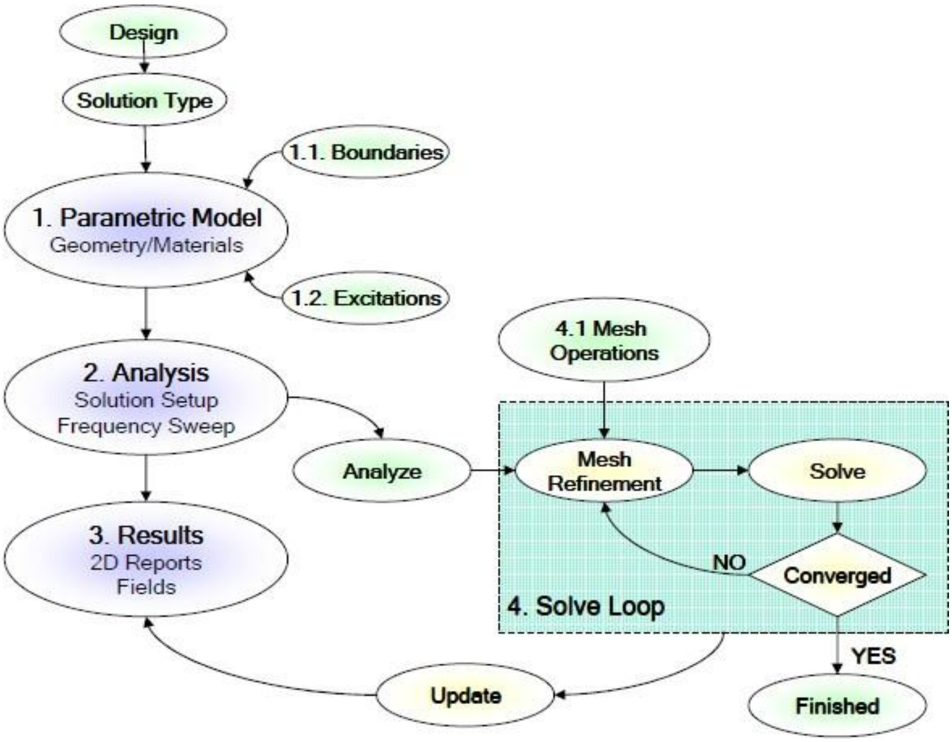


Fig 1.11: Flow Chart of Ansoft HFSS

1.15 Plotting Data:

Data plotting can take a variety of forms. The most often used format is 2DCartesian plotting, but we also have the capability to plot in 3D as well. Below is a list of all the quantities that can be plotted on various graphs. For definitions of each of these quantities, see the online help.

➢ **Eigen mode solution**

- Eigen mode Parameters (modes)

➢ **Driven Modal Solution**

- S-parameters
- Y-parameters
- Z-parameters
- VSWR

- Gamma (complex propagation constant)
- Port Zo

- **Driven Terminal Solution**

- S-parameters
- Y-parameters
- Z-parameters
- VSWR
- Power (at port)
- Voltage Transform matrix (T)
- Terminal Port Zo

- **Fields**

- Mag_E
- Mag_H
- Mag_Jvol
- Mag_Jsurf
- ComplexMag_E
- ComplexMag_H
- ComplexMag_Jvol
- ComplexMag_Jsurf
- Local_SAR (Specific Absorption Rate)
- Average_SAR

- **Types of Plots:**

- Rectangular Plot
- Polar Plot
- 3D Rectangular Plot
- 3D Polar Plot
- Smith Chart
- Data Table
- Radiation Pattern

- **To Create a Plot:**

- Select HFSS > Results > Create Report
- Select Report Type and Display Type from the selections above

- Click OK and the Report Editor will be displayed – we will go over the options in this dialog on the next page.

- **3D Plots:**

simply add a third dimension such that instead of plotting a family of curves, you can plot a 3D surface that represents your data changing with two independent variables. Below is a 3D plot of the previous family of curves.

- **Output Variable:**

In addition to being able to plot the built-in solved quantities, you can also create your own by using output variables.

CHAPTER 2

LITERATURE SURVEY

We are done on Design of a Patch Antenna for 5G Communication Systems such as Wi-Fi, WiMAX, and 5G mobile hand based on Wi-Fi improves the third-generation (3G) cellular and long-term evolution (LTE) broadband internet access, for improving WiMAX bandwidth for 5G mobile hand set very large frequency of operation are being considered and this will present some real challenges in terms of the circuit design. But this paper only considers the actual dimensions of the antenna and the frequency of operation. Upon this review we must do in addition to these of dimensionand frequency of operation concepts the antenna parameters such as return loss, directivity, antenna efficiency, gain can also improve by considering the permittivity of the dielectric martial (substrate), the number of slots in the micro strip patch antennaand the size.

MIMO antennas have emerged as a promising solution to address the increasing demand for miniaturization and cost-effectiveness in communication technology, particularly in the context of 5G applications. Recent advancements in microstrip antenna designs have focused on achieving compact structures without compromising performance. A comparative study of miniaturization techniques, including slotted radiators and dual-element configurations, highlights their effectiveness in reducing antenna size while maintaining desired performance characteristics. Additionally, substrate material selection plays a crucial role in microstrip antenna design. Rogers 4350B substrate has garnered attention due to its superior properties, such as high signal integrity, low loss, and excellent performance characteristics, making it an idealchoice for 5G applications. Simulation tools like Ansoft High-Frequency Structure Simulator (HFSS) have become indispensable in the design and analysis of microstripantennas. These tools enable researchers to simulate various performance parameters,including S-parameters, VSWR, and gain, facilitating the validation of antenna designs prior to fabrication. Performance evaluation studies of microstrip antennas for5G applications provide valuable insights into their suitability for modern communication systems. These studies analyze key performance metrics such as return loss, ECC, diversity gain, and gain, offering comprehensive assessments of antenna performance at high frequencies. Experimental validation using simulation software further enhances the credibility of these studies, contributing to the advancement of microstrip antenna technology for 5G applications.

In addition to addressing the technical challenges of miniaturization and cost-effectiveness, microstrip antennas have significant implications for 5G communication applications. The high-frequency operation and compact form factor of these antennas make them well-suited for various 5G use cases, including ultra- reliable low-latency communication (URLLC), massive machine-type communication (mMTC), and enhanced mobile broadband (eMBB). Their ability to support high datarates and reliable connectivity in dense urban environments aligns with the requirements of emerging 5G networks. Furthermore, microstrip antennas offer flexibility in deployment, making them suitable for integration into small cell networks, Internet of Things (IoT) devices, and next-generation mobile devices. By enabling efficient communication in diverse scenarios, microstrip antennas play a crucial role in realizing the full potential of 5G technology, driving innovations in areas such as smart cities, autonomous vehicles, and augmented reality applications.

CHAPTER 3

EXISTING DESIGN

3.1 Introduction

A MIMO antenna incorporates minimum two radiating elements, placed at a specific distance to achieve minimum mutual coupling between them, but very limited space is available in front-end modern communication systems. Different approaches have been recommended by the researcher to reduced mutual coupling between the radiators. In, a stub on the lower ground plane was used in perpendicularly placed radiators to achieve minimum mutual coupling.

The design evolution of the DEAF Antenna design is presented in Fig. 3.1. The proposed antenna has overall dimensions of 11.4×6.3×0.8 mm, which occupies less volume compared to other antennas. Two radiating patches with slits are printed on Roger 4350B substrate with 0.8 mm thickness and relative permittivity of 3.66. The length and width of the radiators were 3.6 mm and 2.7 mm, respectively. A patch-antenna is a metallic area suspended above a ground plane. They are simpler to construct, modify and adaptive. These are built on a die-electric insulator or substrate, Similar to an IC fabrication process.

The proposed design is shown in Fig. 3.1. The antenna elements are evolved from a simple rectangular patch antenna. The proposed antenna uses Flexible Rogers 4350B laminate as a substrate. The dielectric constant of the substrate is 3.36 and the thickness of the substrate is 0.8 mm. The proposed antenna has a compact size of 11.4 mm x 6.3 mm. The antenna is fed by a 50 Ω micro strip line.

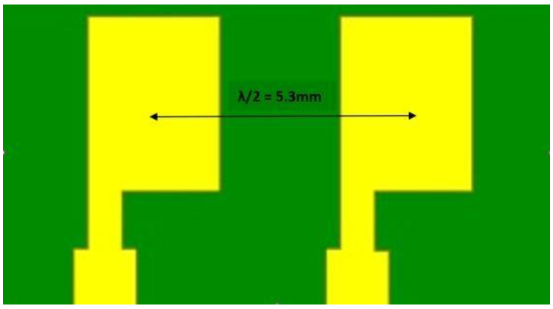


Fig 3.1: Layout of DEAF Antenna

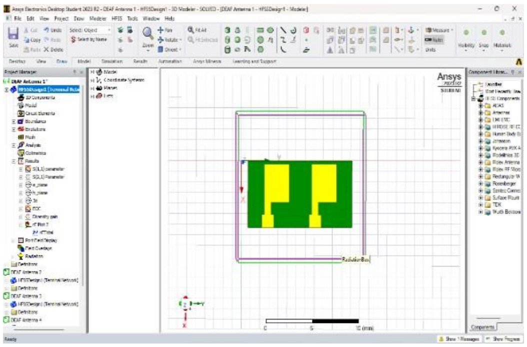


Fig 3.2: DEAF Antenna using HFSS

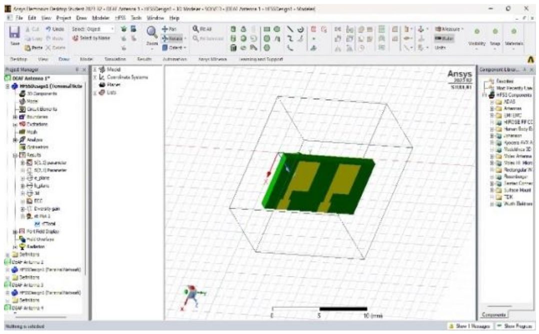


Fig 3.3: 3D view of DEAF Antenna Design

A micro-strip antenna has a patch called as radiating patch and a dielectric substrate having the ground plane on the other side. The strip uses a λ/2 length patch with a bigger ground plane for good performance at the cost of size. The ground planeis moderately large when compared to that of the patch. The flow of current is in the feed direction. Such the electric field E and vector potential follows the current. Antenna radiates linearly polarized wave. The radiations are shaped due to slots that radiates both on the top and the bottom, which results in the current flow.

3.2 Antenna Parameters:

Analysis of various parameters like Effective Length, Effective Width, and Effective Dielectric constant.

Width of the patch:

$$\boldsymbol{W = \frac{C}{2f_0\sqrt{\frac{(\varepsilon_r + 1)}{2}}}}$$

Length of the Patch:

$$\boldsymbol{L = L_{eff} - 2\Delta}$$

Where:

W- width of the patch

C - velocity of light (3x10^11mm)

L - length of the patch

ε_r - dielectric constant of substrate

Effective length is given by:

$$L_{eff} = \frac{C}{2f_{0\sqrt{\varepsilon_{eff}}}}$$

Normalized extension in length is given by:

$$\frac{\Delta L}{h} = 0.412\frac{(\varepsilon_{reff} + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\epsilon_{reff} - 0.258)\left(\frac{W}{h} + 0.8\right)}$$

Effective Dielectric Constant:

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2\sqrt{1 + \frac{12h}{w}}}$$

The design parameters of the DEAF

Table1: Design Parameters of DEAF Antenna

Parameters	Dimensions
Length of the substrate	11.4mm
Width of the substrate	6.3 mm
Height of the substrate	0.8 mm

3.3 Results of Existing Design:

At 29 GHz Frequency we have the following results:

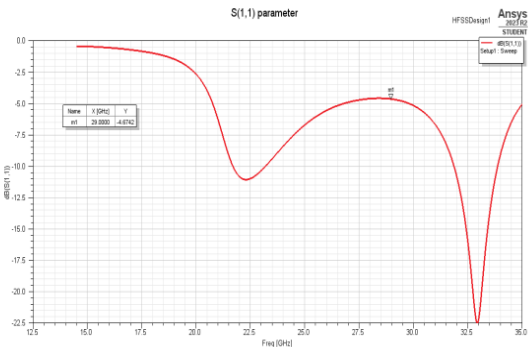


Fig 3.4: Return Loss of an Antenna

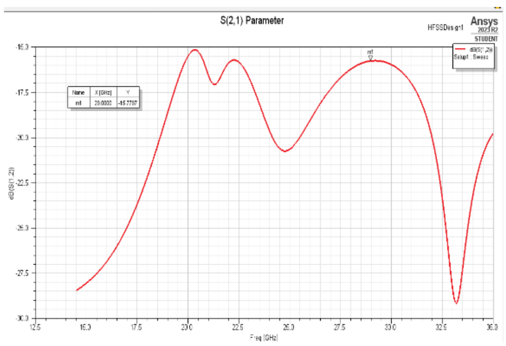


Fig 3.5: Transmission Gain of an Antenna

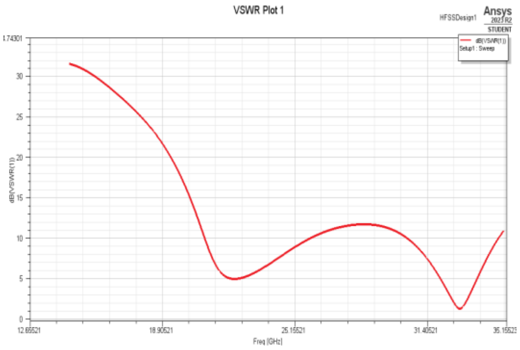


Fig 3.6: VSWR Plot of an Antenna

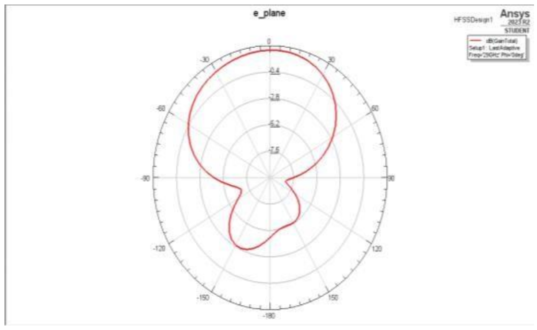


Fig 3.7: e_plane of an Antenna

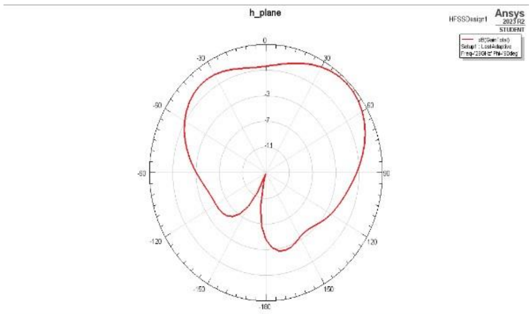


Fig 3.8: h_plane of an Antenna

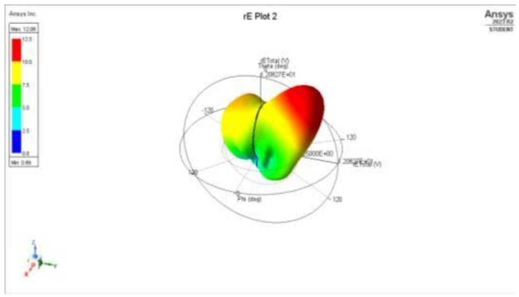


Fig 3.9: 3D Gain Plot an Antenna

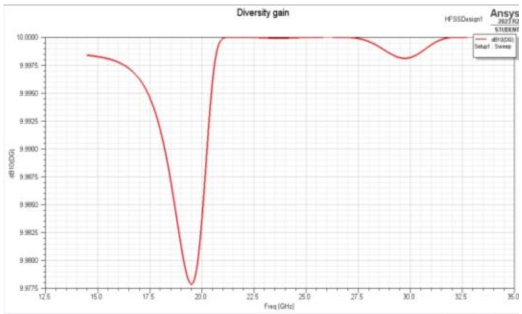


Fig 3.10: Diversity Gain of anAntenna

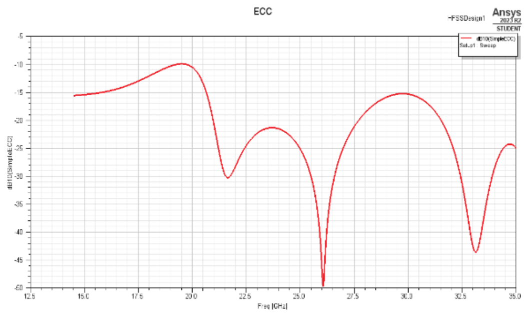


Fig 3.11: ECC of an Antenna

Table 2: Tabular Representation of Antenna Results

Parameters	**Deaf Antenna 1**
Return Loss	-4.671
Transmission Gain	-18.00
VSWR	11.499
ECC	-19.85
Diversity Gain	9.998

3.4 Problem Statement:

The performance of Antenna 1 falls short of desired benchmarks with a Return Loss of -4.671 dB and a VSWR of 11.499, indicating suboptimal impedance matching and signal reflection. However, its Diversity Gain of 9.998 showcases potential for signal robustness in varied environments. To enhance its performance, adjustments can be made to improve Return Loss to below -10 dB and VSWR to less than 2, ensuring better impedance matching and reduced signal loss. Additionally, optimizing Transmission Gain to mitigate signal attenuation and fine-tuning ECC for improved energy efficiency are essential. By refining these parameters, Antenna 1 can achieve superior performance, enabling reliable and efficient communication in diverse applications, including 5G networks and IoT deployments.

CHAPTER 4

IMPLEMENTATION OF PROPOSED DESIGN

4.1 Introduction:

A patch-antenna is a metallic area suspended above a ground plane. They are simpler to construct, modify and adaptive. These are built on a die-electric insulator or substrate, similar to an IC fabrication process. A micro-strip antenna has a patch called as radiating patch and a dielectric substrate having the ground plane on the other side. The strip uses a λ/2 length patch with a bigger ground plane for good performance at the cost of size. The ground plane is moderately large when compared to that of the patch. The flow of current is in the feed direction. Such the electric field E and vector potential follows the current. Antenna radiates linearly polarized wave. The radiations are shaped due to slots that radiates both on the top and the bottom, which results in the current flow.

The design is shown in below figures. The antenna elements are evolved froma simple rectangular patch antenna. The proposed antenna uses Flexible Rogers 4350B laminate as a substrate. The dielectric constant of the substrate is 3.36 and the thickness of the substrate is 0.8 mm. The proposed antenna has a compact size of 11.4mm x 6.3 mm. The antenna is fed by a 50 Ω micro strip line.

The proposed DEAF Antenna is done with four layouts in which the layout 1+, layout 2 are having two radiating elements which are separated by a distance of λ/2 length i.e., half the wavelength of the antenna and the other two layouts layout 3 and layout 4 are also having two radiating elements which are separated by a distance of λ/3 length i.e, one by third of the wavelength of the antenna operating at a frequency of 37GHz. The below layouts are designed to find the best effective length for separating the radiating elements of the antenna for better performance characteristics.

4.2 DEAF Antenna 1

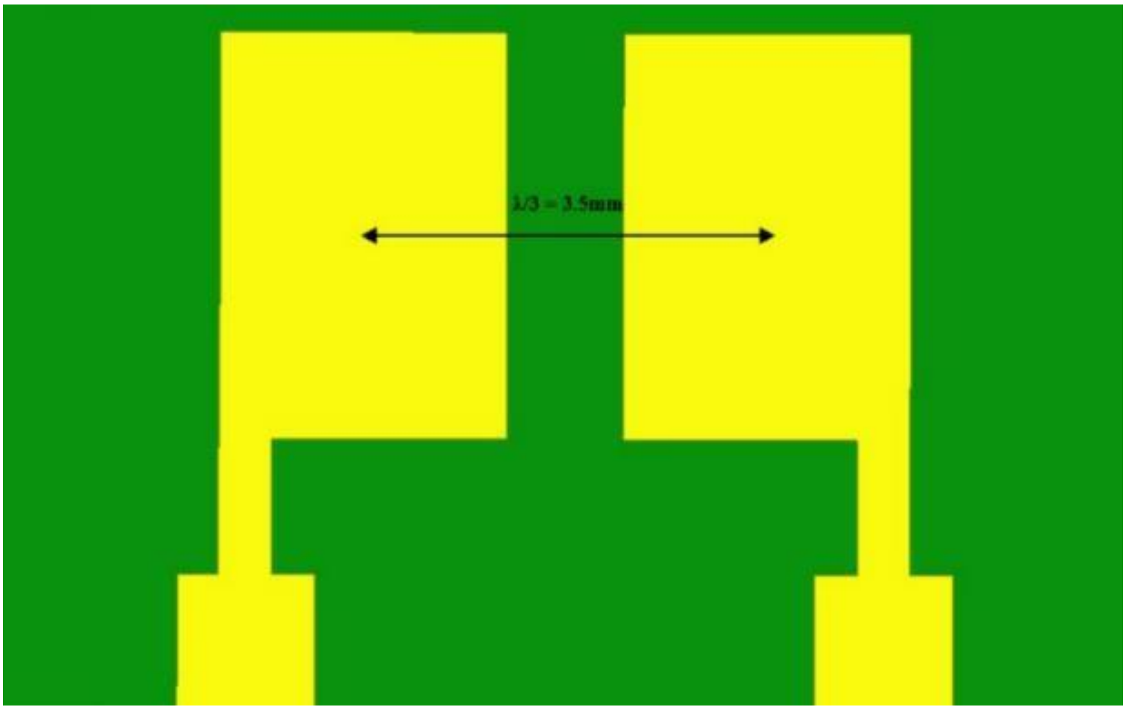


Fig 4.1: Layout of DEAF Antenna 1

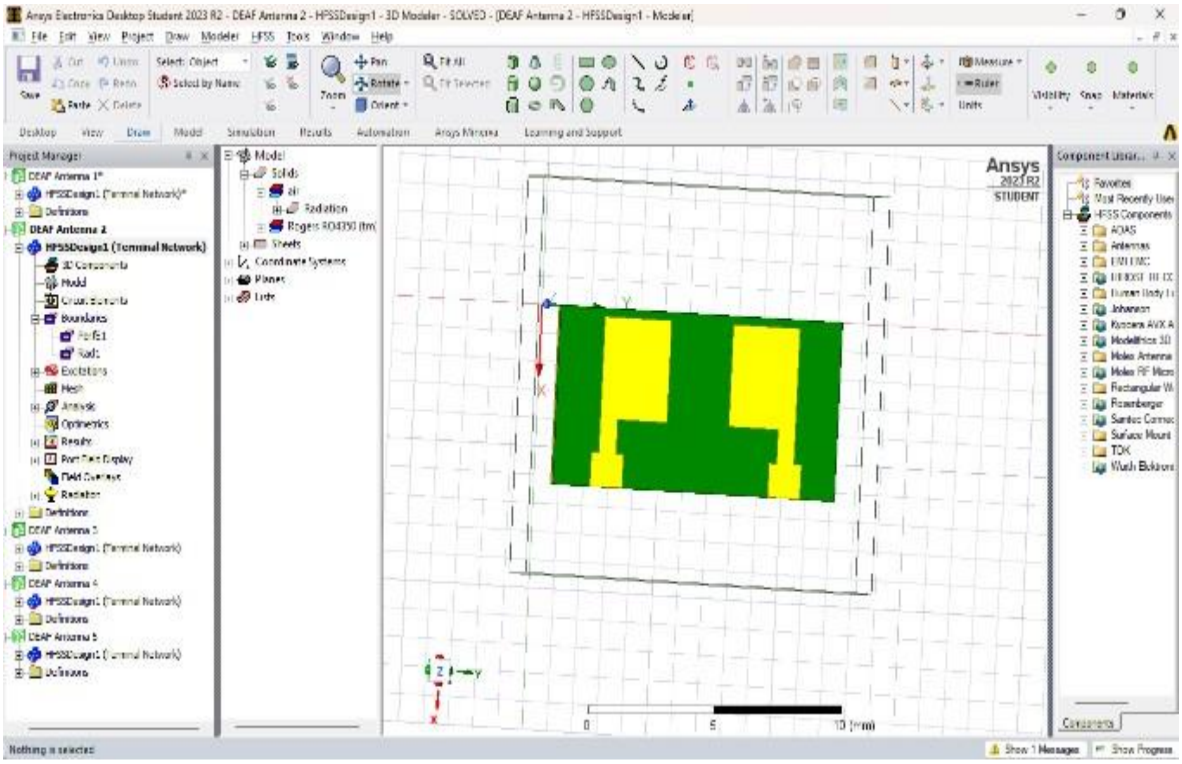


Fig 4.1.2: DEAF Antenna 1 using HFSS

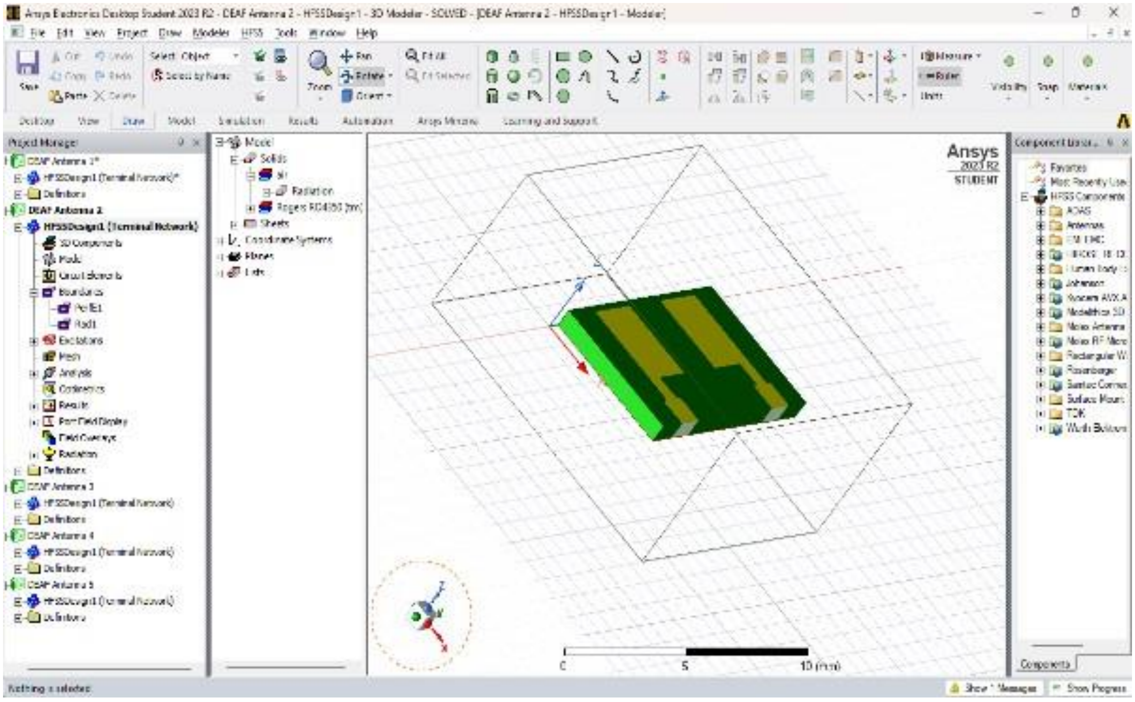


Fig 4.1.3: 3D view of DEAF Antenna 1

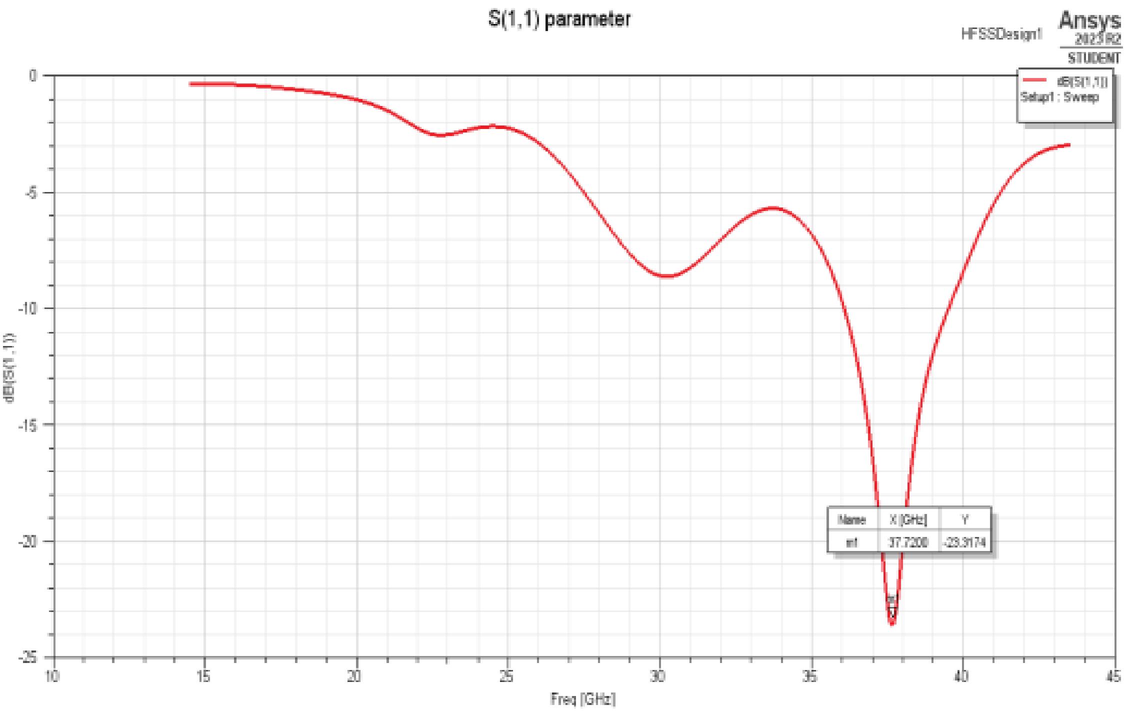


Fig 4.1.4: Return Loss of DEAF Antenna 1

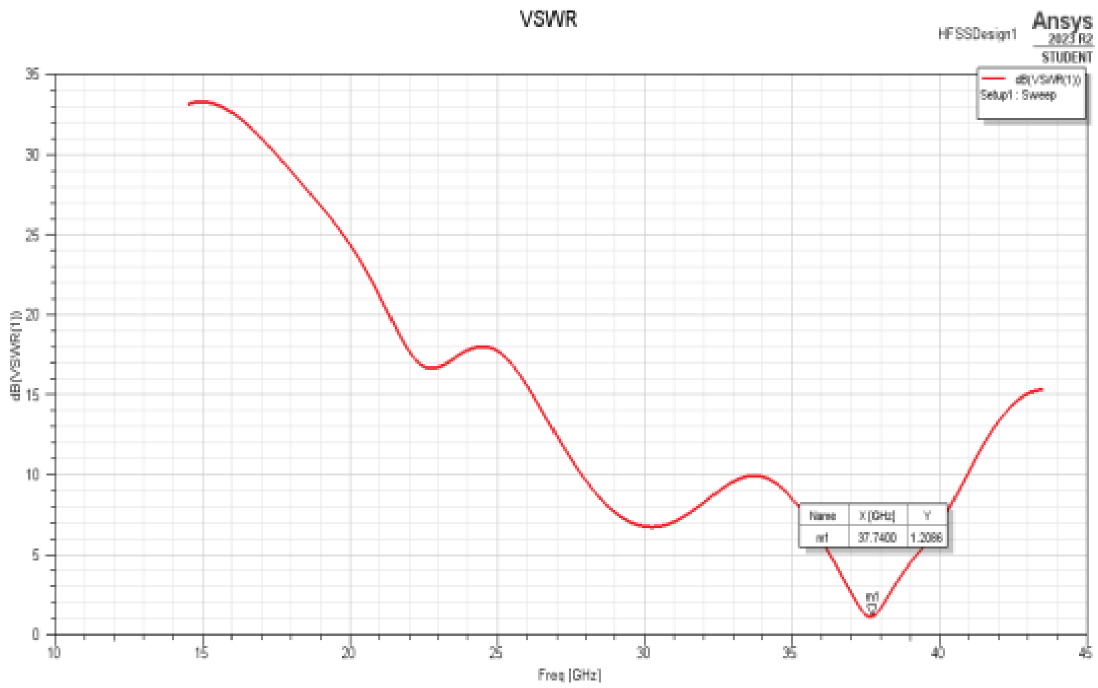


Fig 4.1.5: VSWR of DEAF Antenna 1

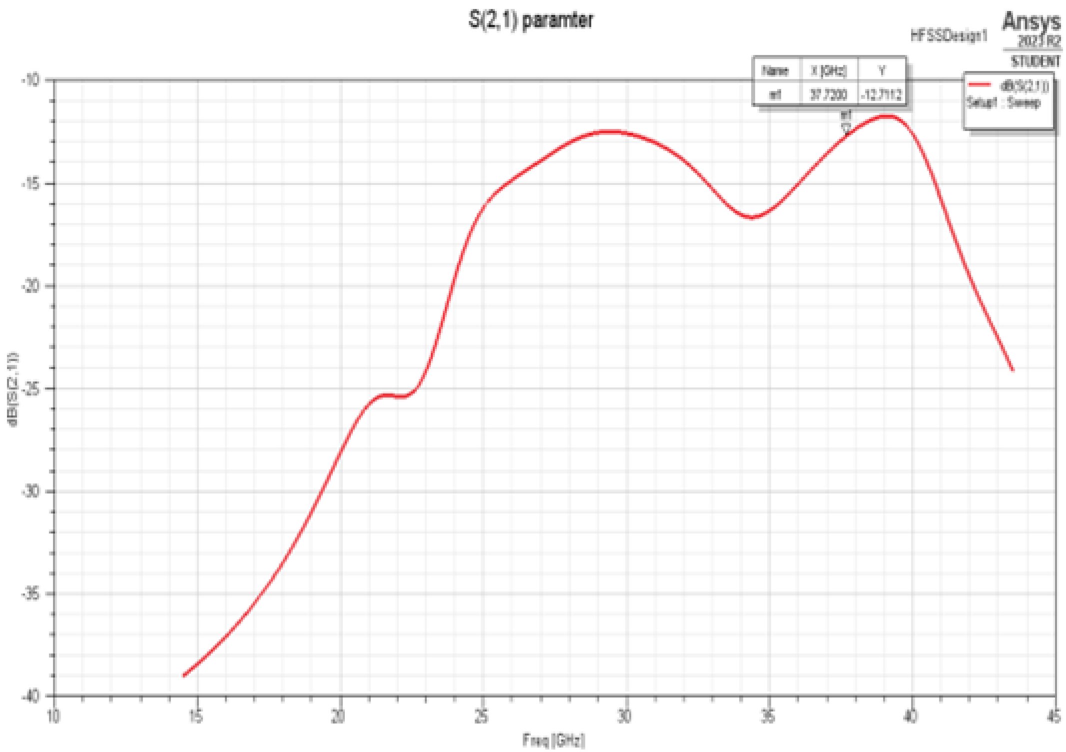


Fig 4.1.6: Transmission Gain of DEAF Antenna 1

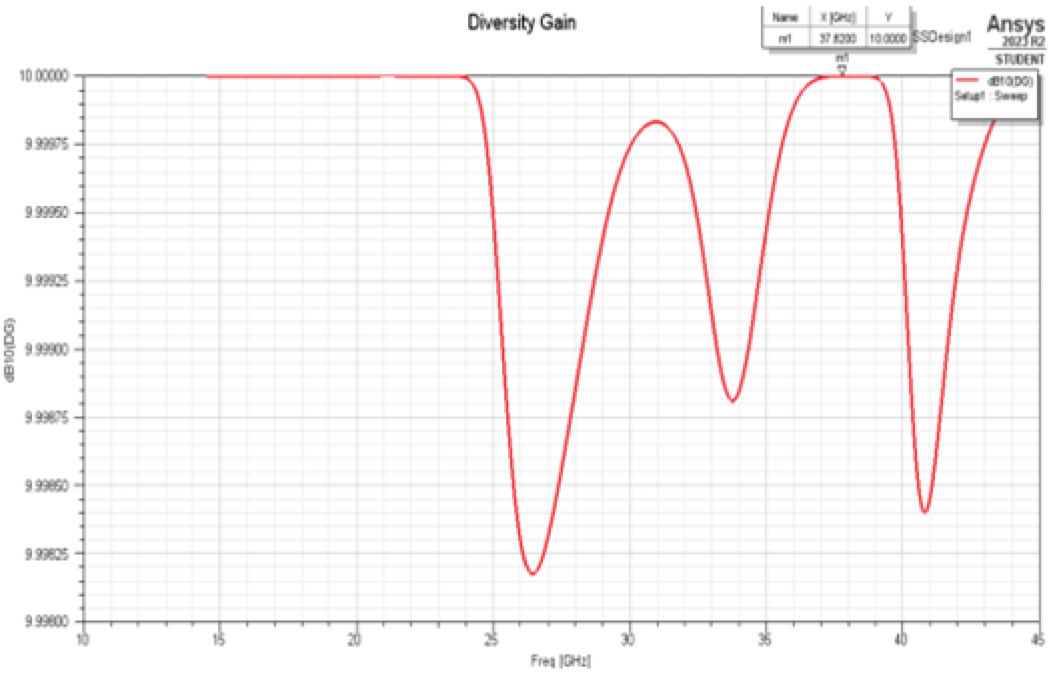


Fig 4.1.7: Diversity Gain of DEAF Antenna 1

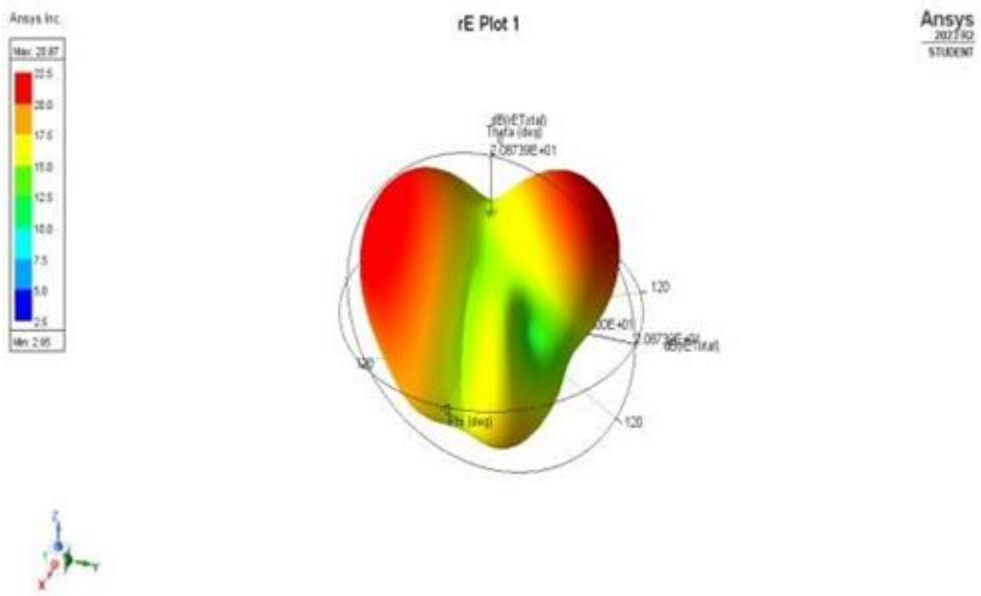


Fig 4.1.8: Gain of DEAF Antenna 1

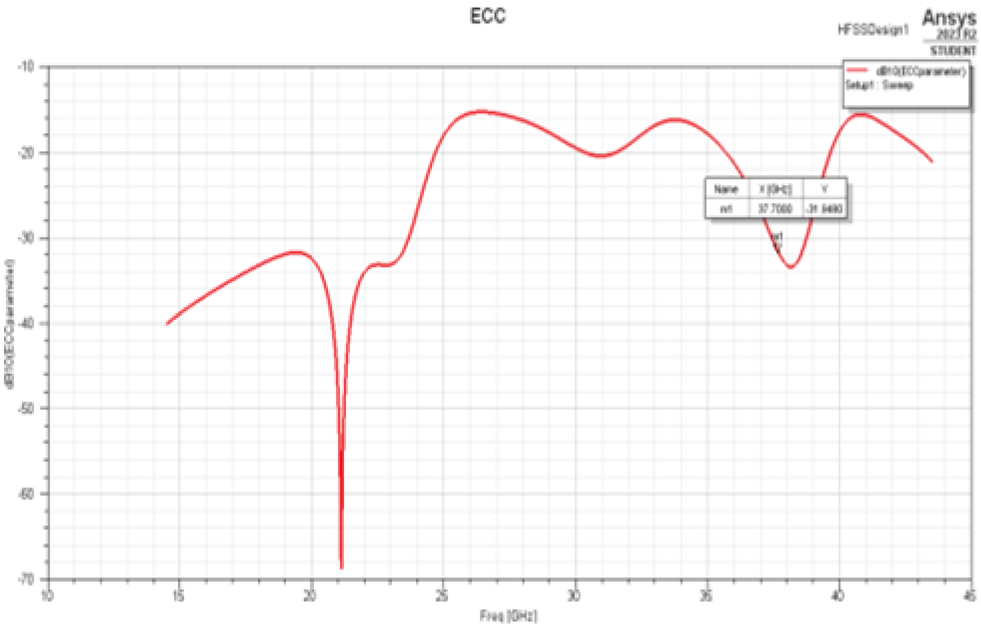


Fig 4.1.9: ECC of DEAF Antenna 1

4.3 DEAF Antena 2

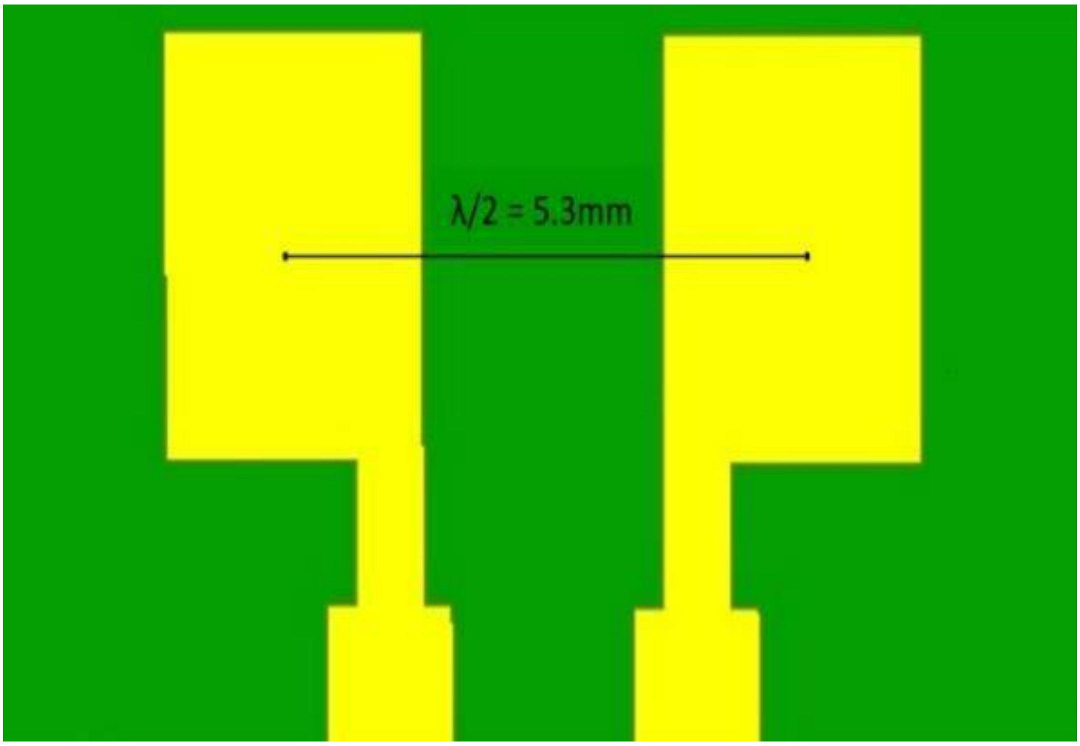


Fig 4.2: Layout of DEAF Antenna 2

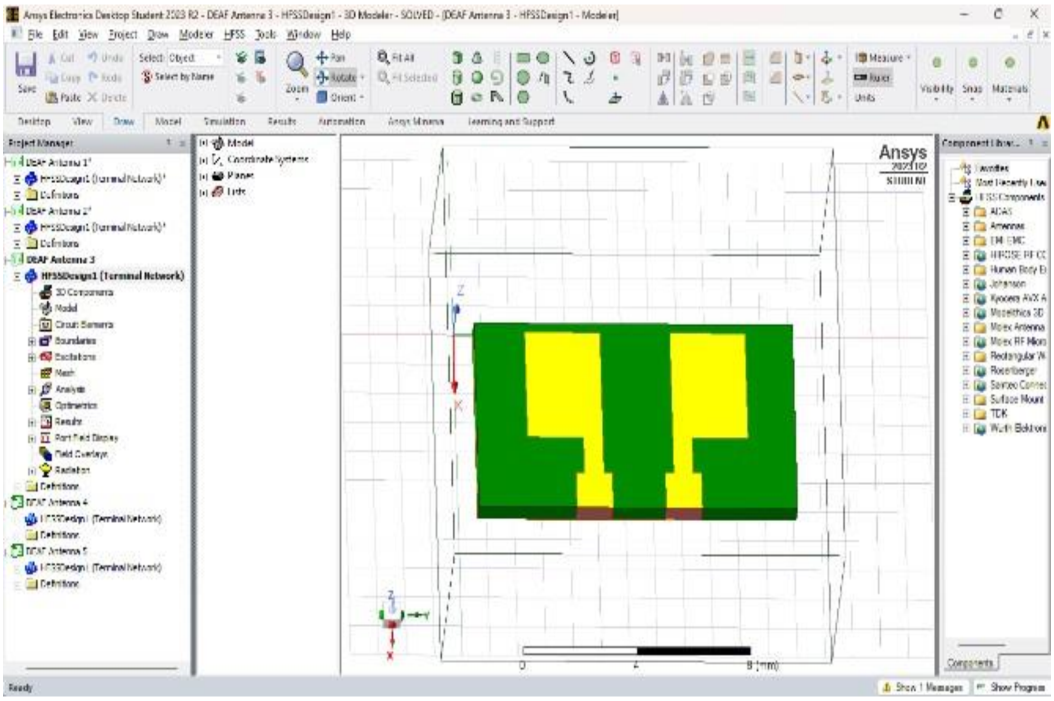


Fig 4.2.1: DEAF Antenna 2 using HFSS

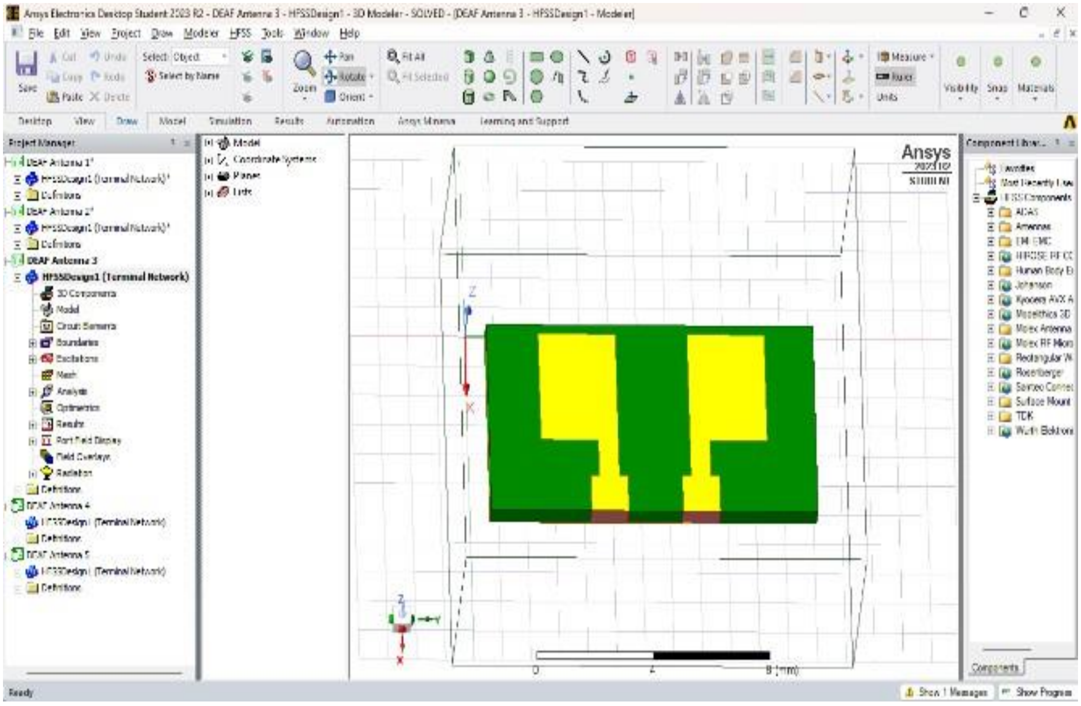


Fig 4.2.2: 3D view of DEAF Antenna 2

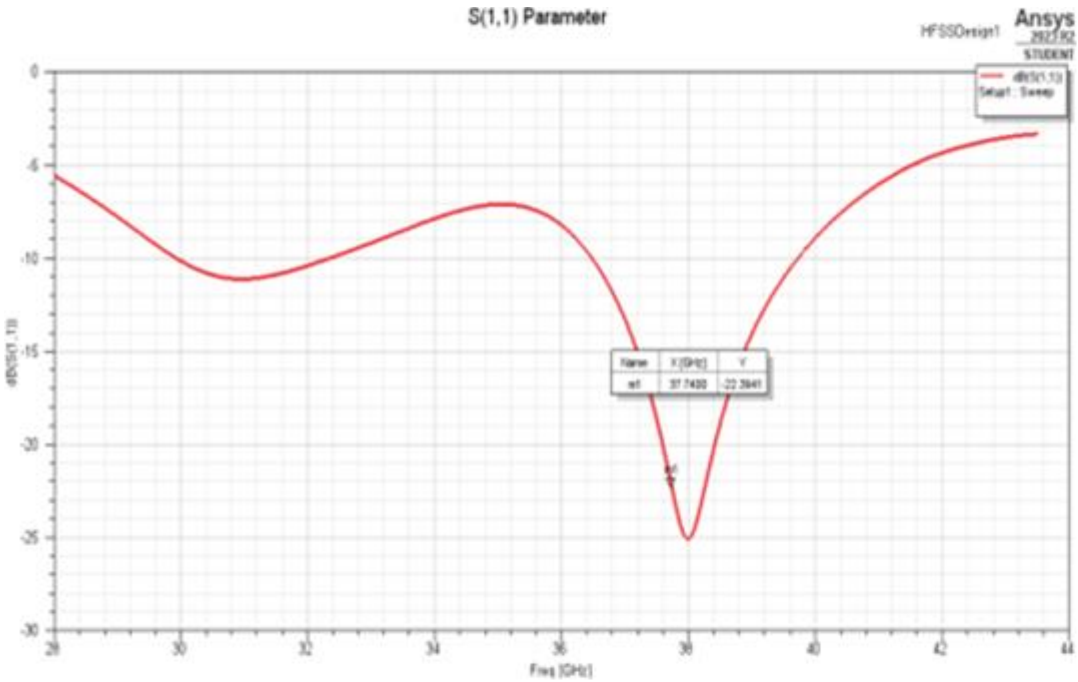


Fig 4.2.3: Return Loss of DEAF Antenna 2

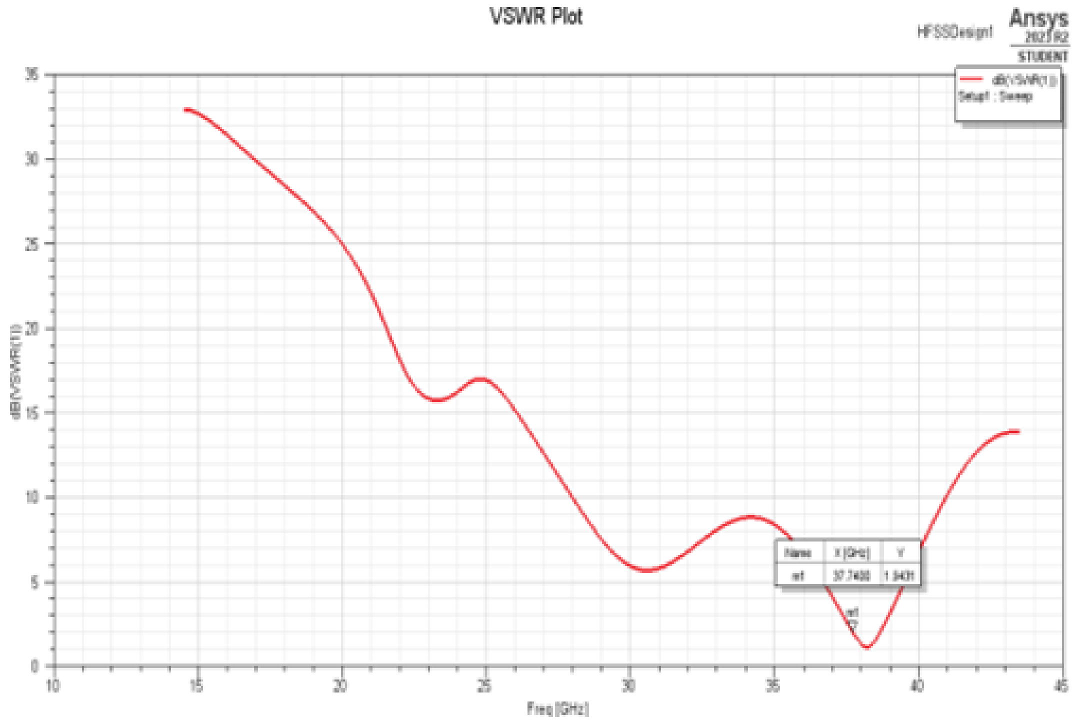


Fig 4.2.4: VSWR of DEAF Antenna 2

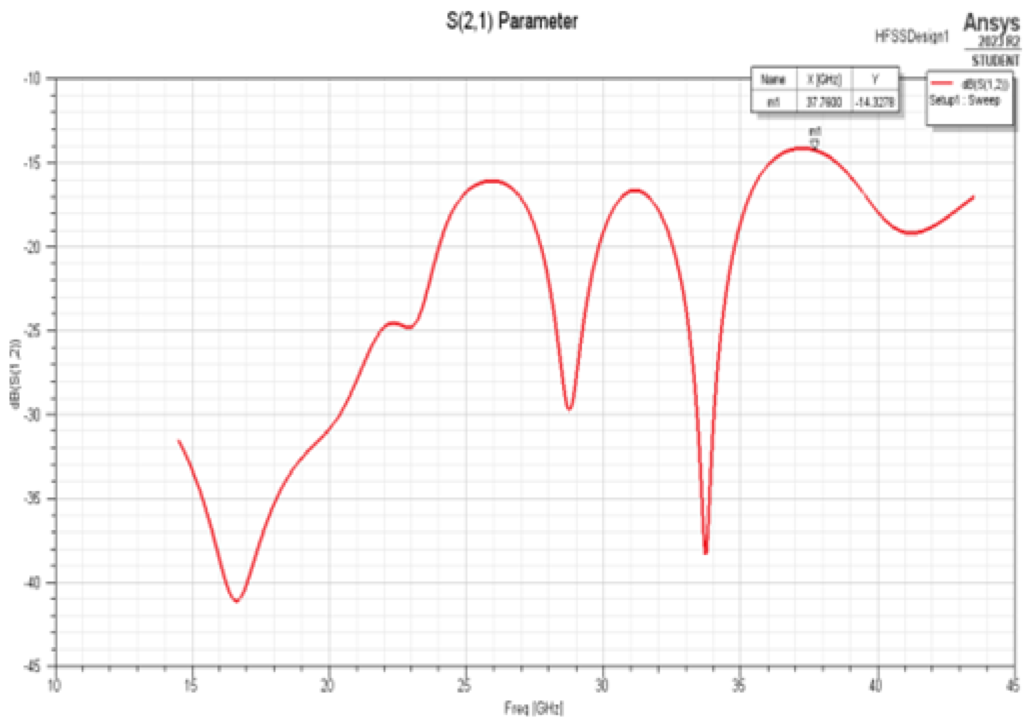


Fig 4.2.5: Transmission Gain of DEAF Antenna 2

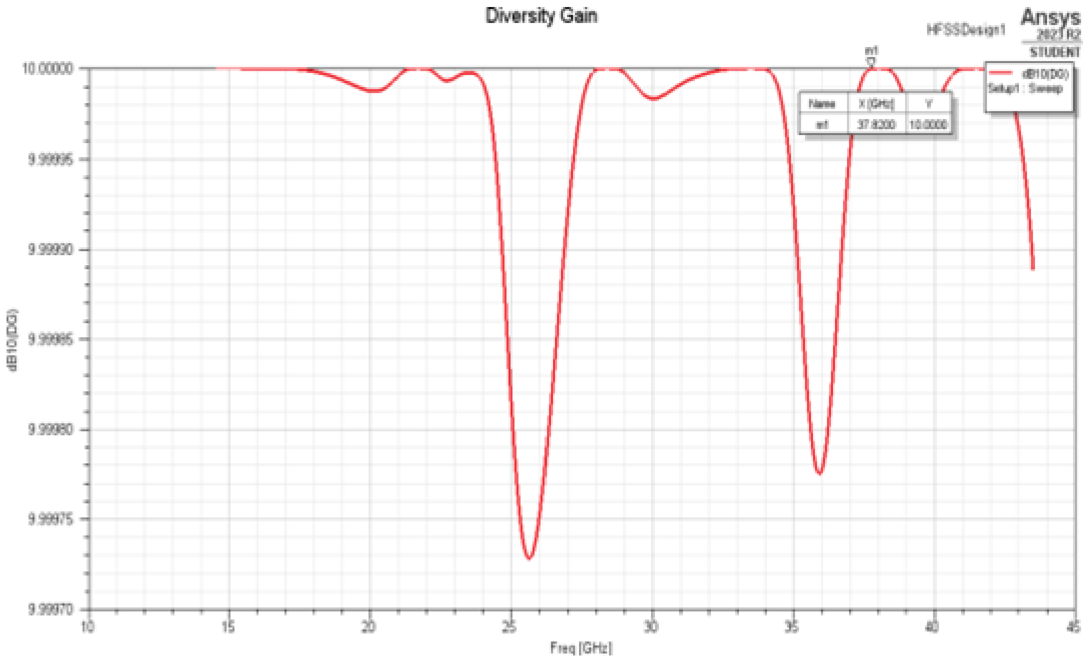


Fig 4.2.6: Diversity Gain of DEAF Antenna 2

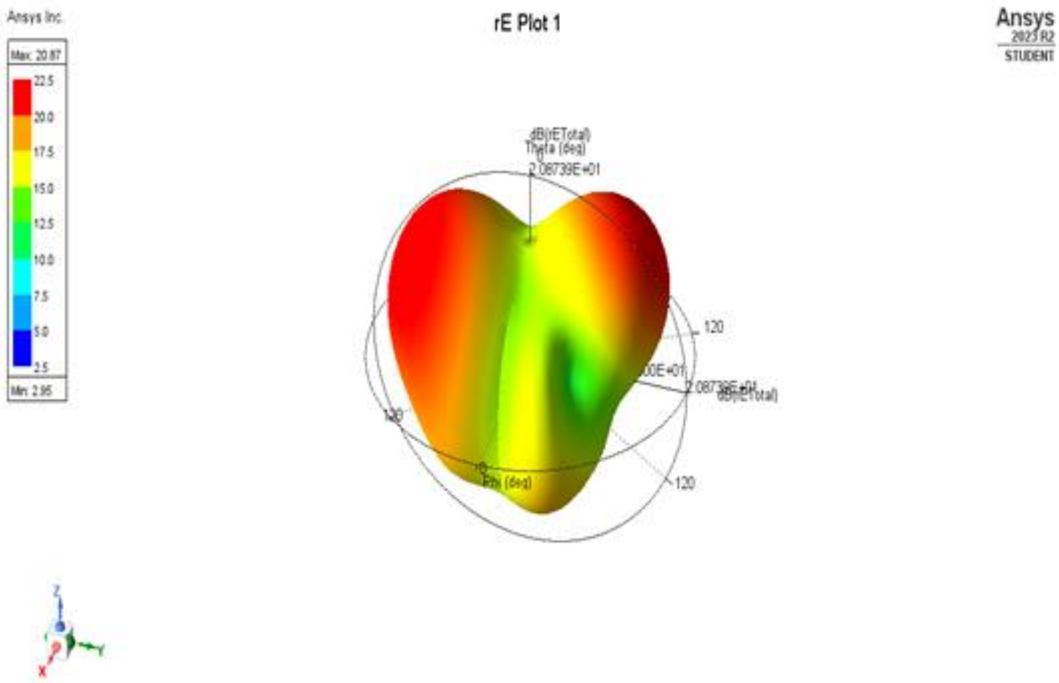


Fig 4.2.7: Gain of DEAF Antenna 2

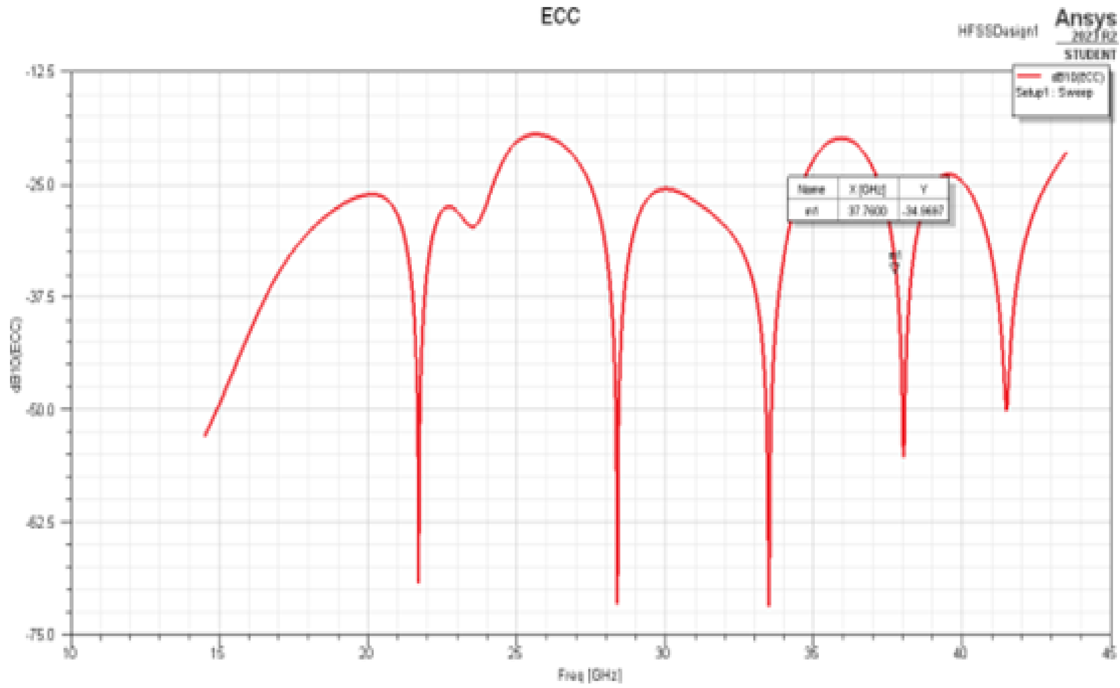


Fig 4.2.8: ECC of DEAF Antenna 2

4.4 DEAF Antenna 3

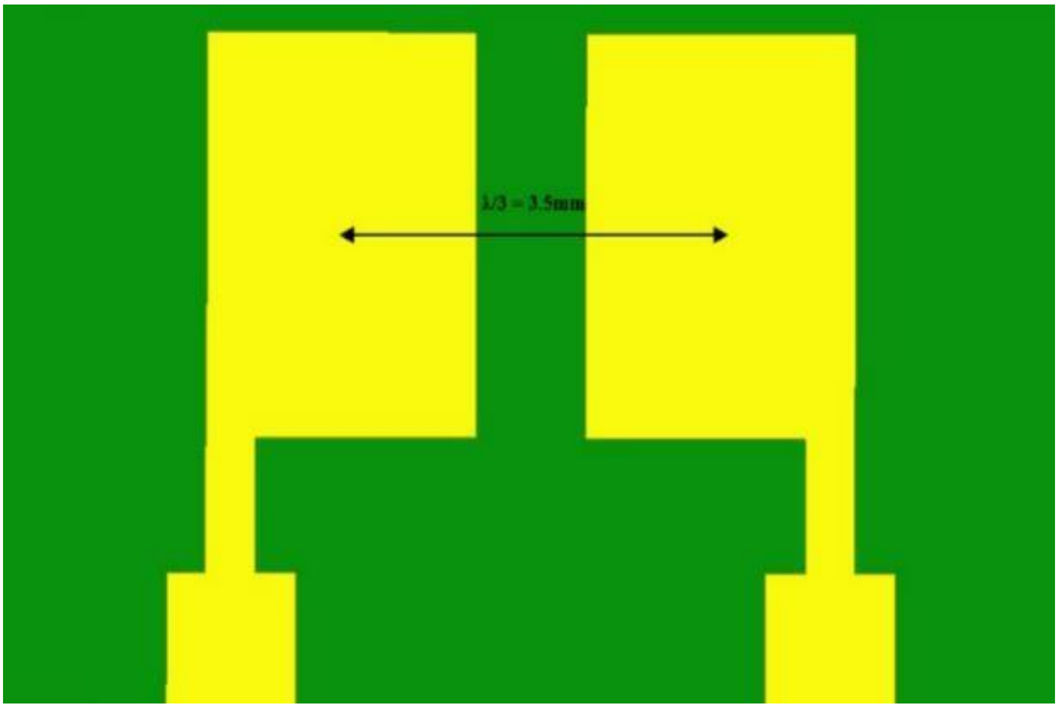


Fig 4.3: Layout of DEAF Antenna 3

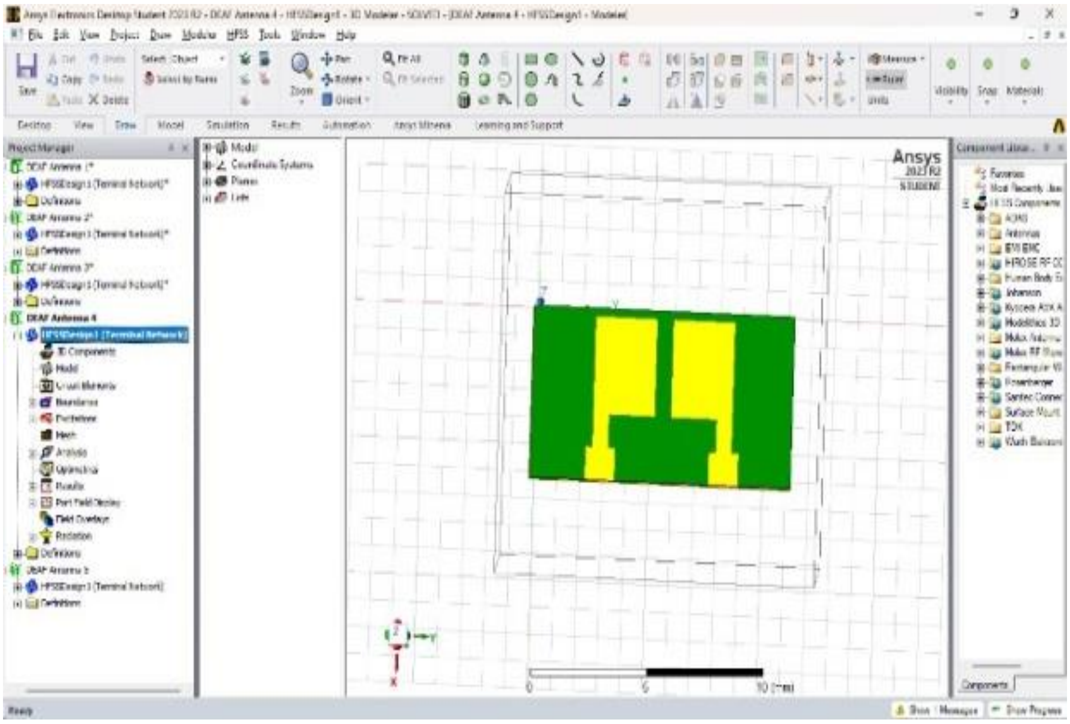


Fig 4.3.1: DEAF Antenna 3 using HFSS

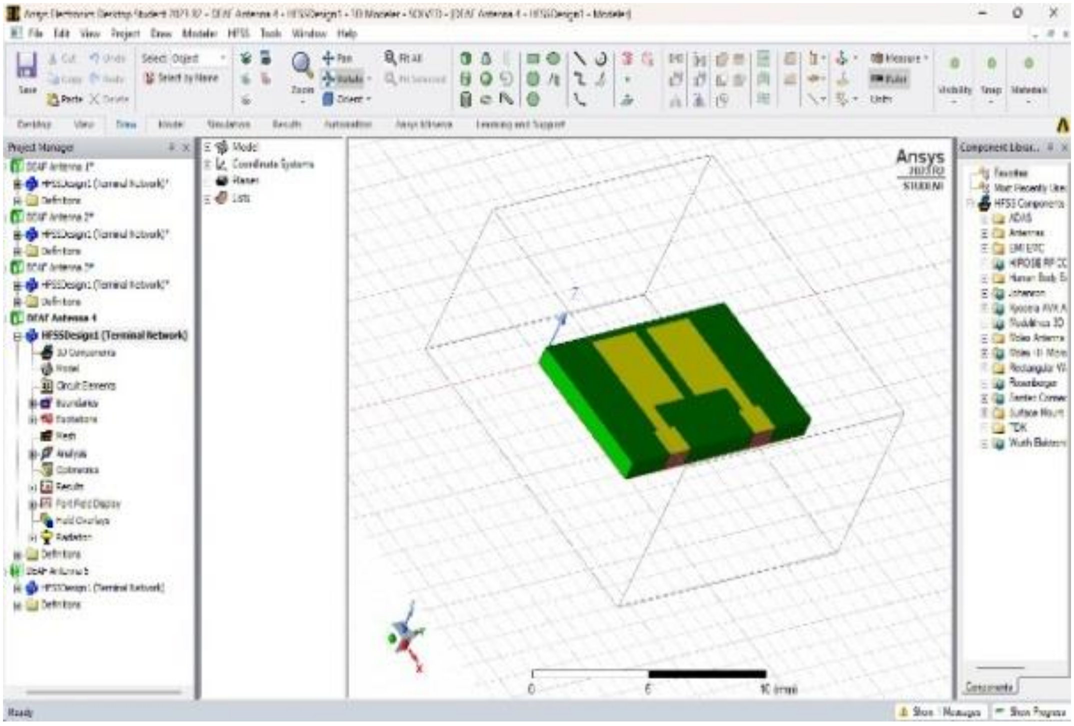


Fig 4.3.2: 3D view of DEAF Antenna 3

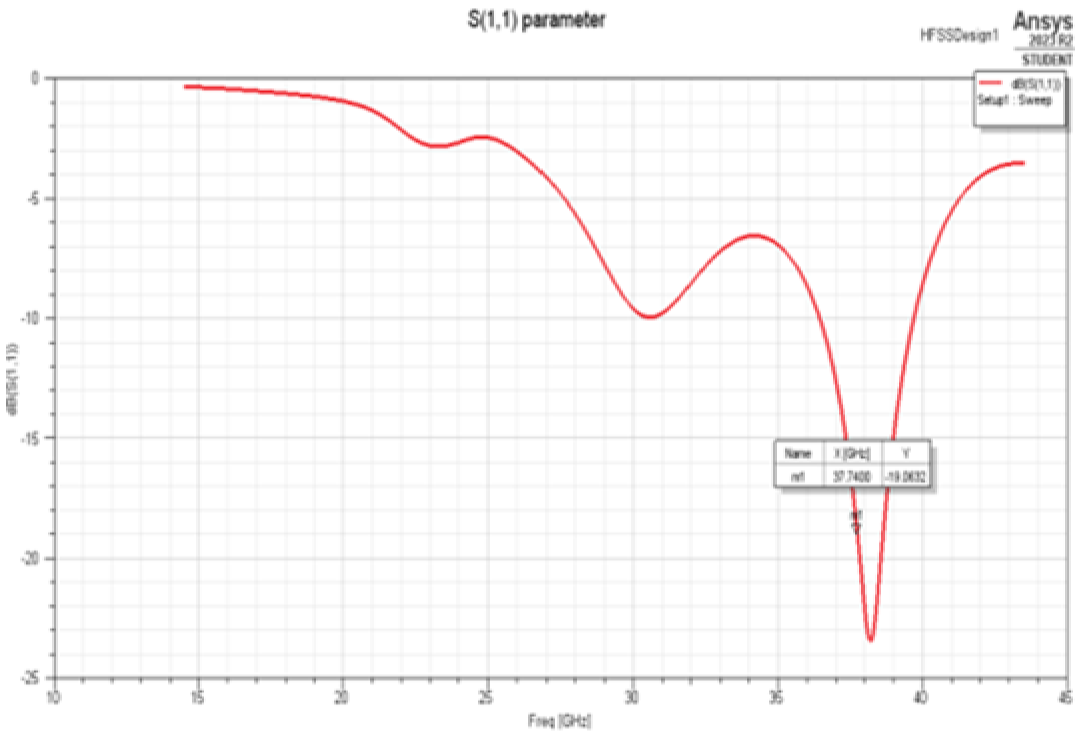


Fig 4.3.3: Return Loss of DEAF Antenna 3

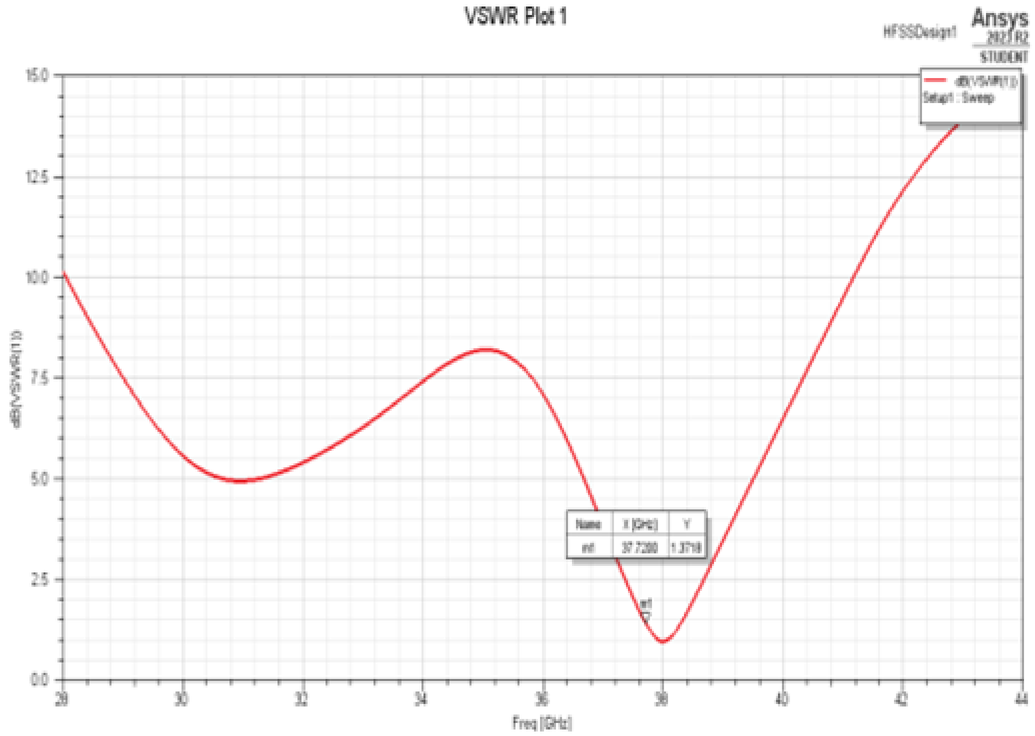


Fig 4.3.4: VSWR of DEAF Antenna 3

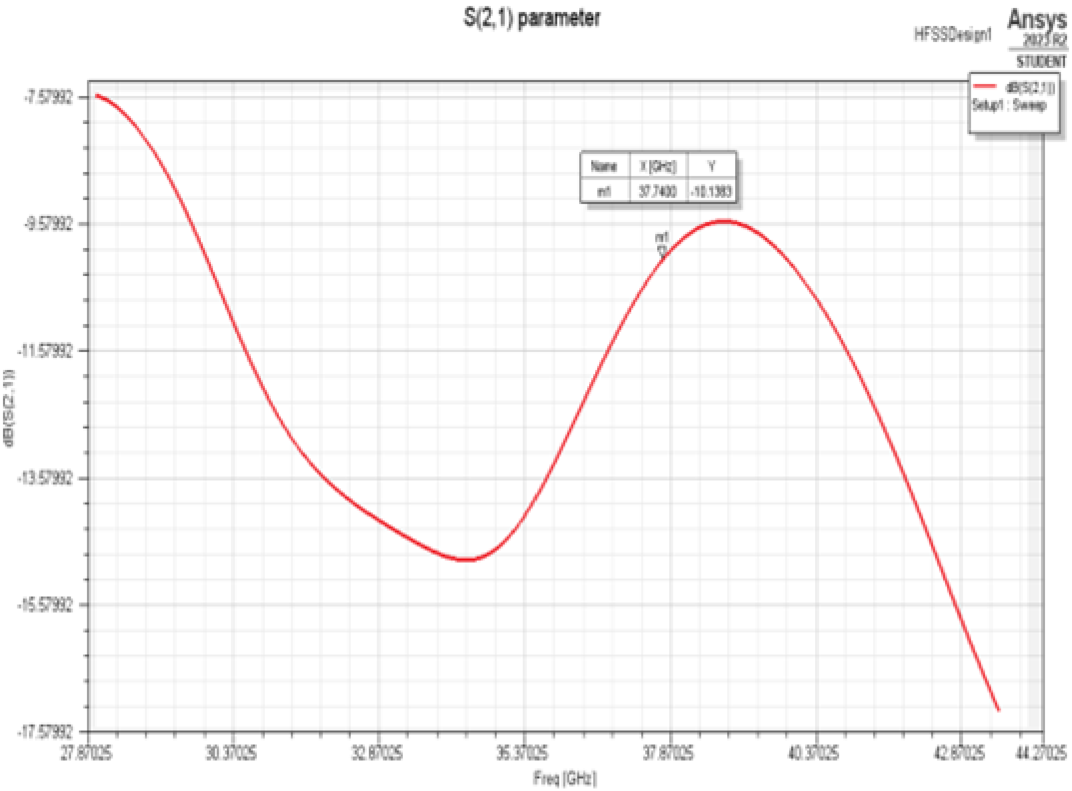


Fig 4.3.5: Transmission Gain of DEAF Antenna 3

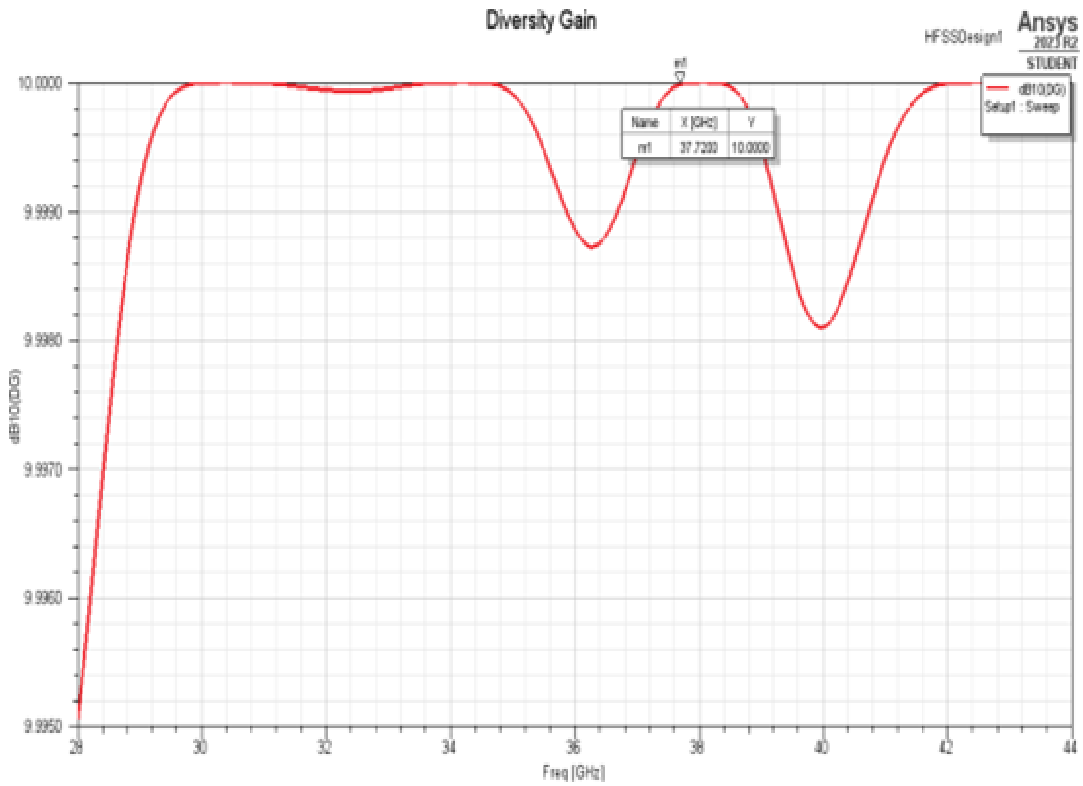


Fig 4.3.6: Diversity Gain of DEAF Antenna 3

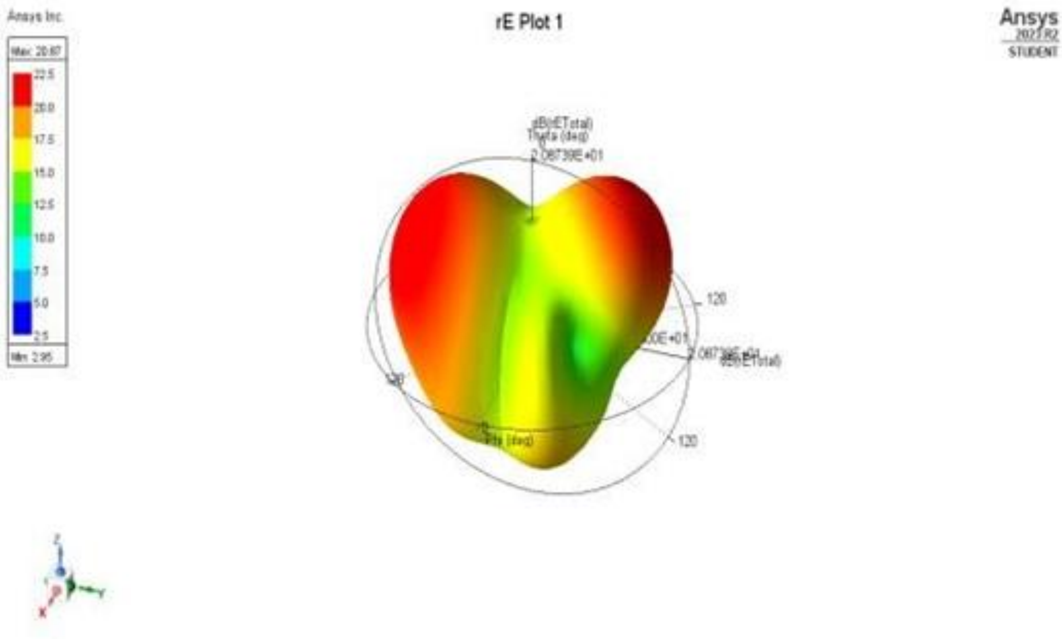


Fig 4.3.7: Gain of DEAF Antenna 3

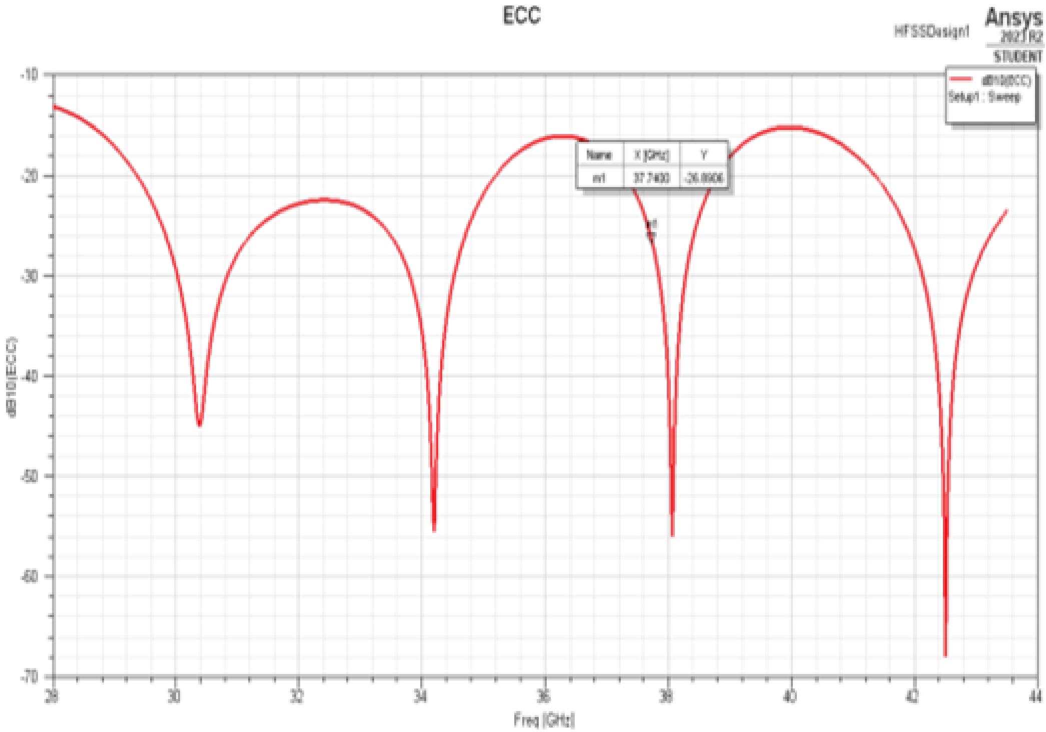


Fig 4.3.8: ECC of DEAF Antenna 3

4.5 DEAF Antenna 4

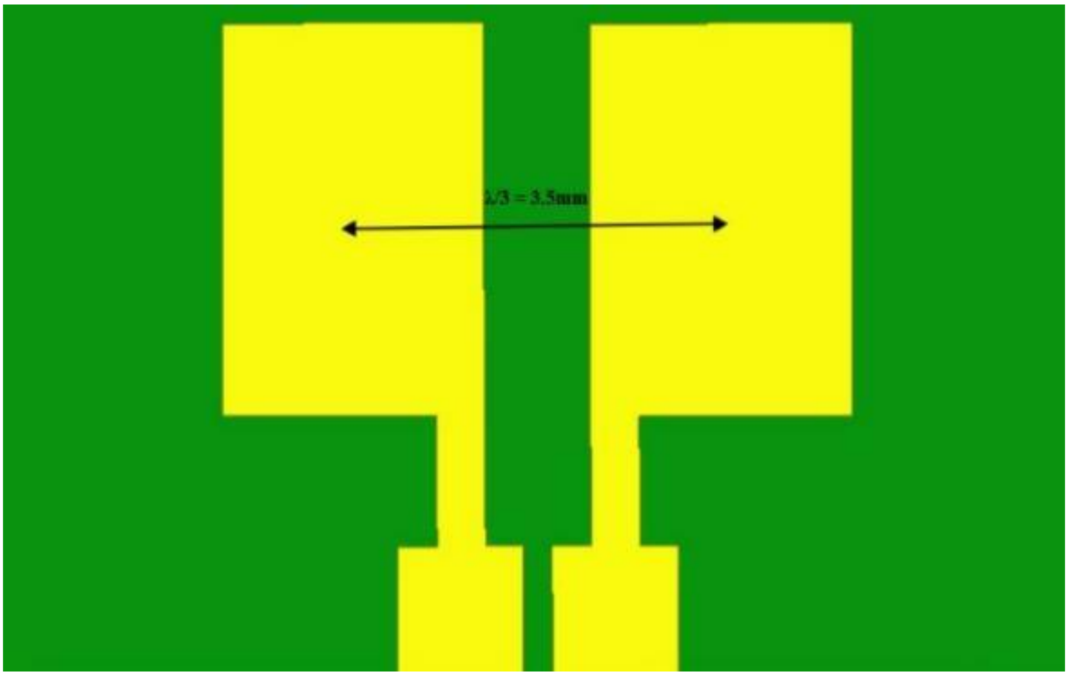
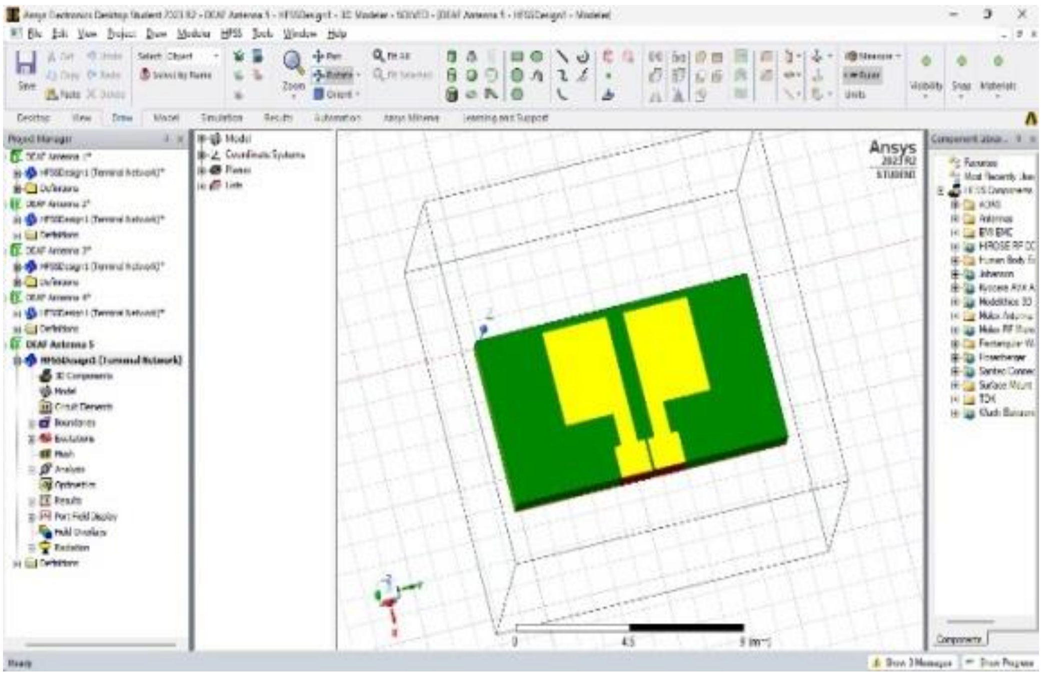


Fig 4.4: Layout of DEAF Antenna 4



4.4.1: DEAF Antenna 4 usingHFSS

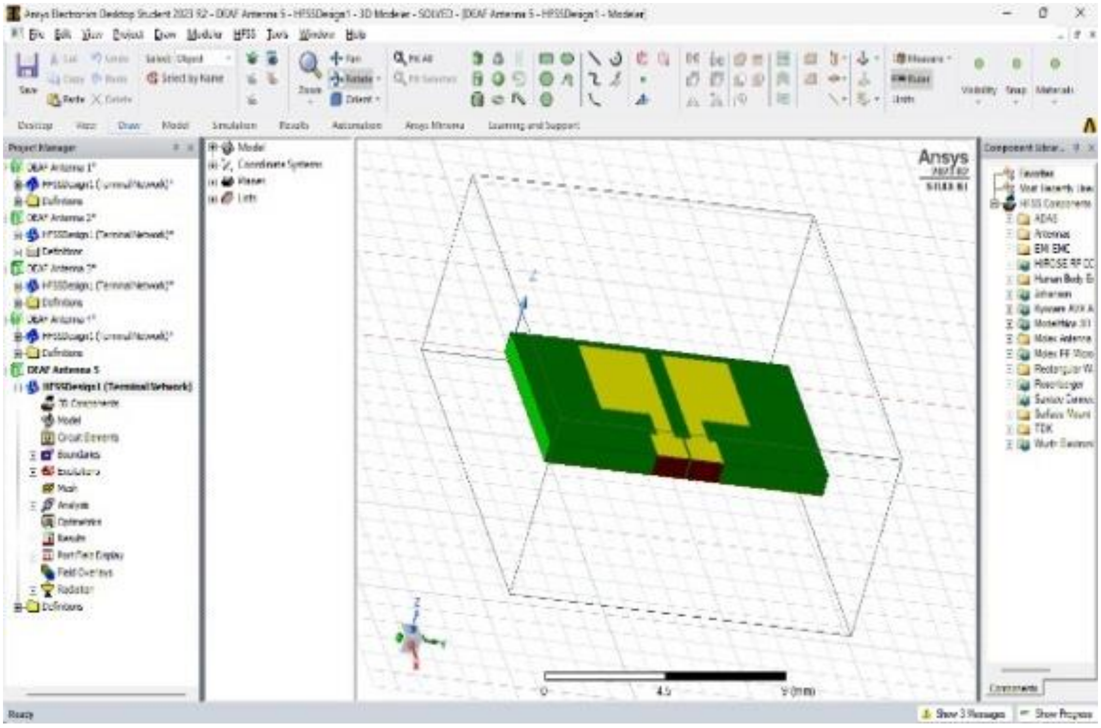


Fig 4.4.2: 3D view of DEAF Antenna 4

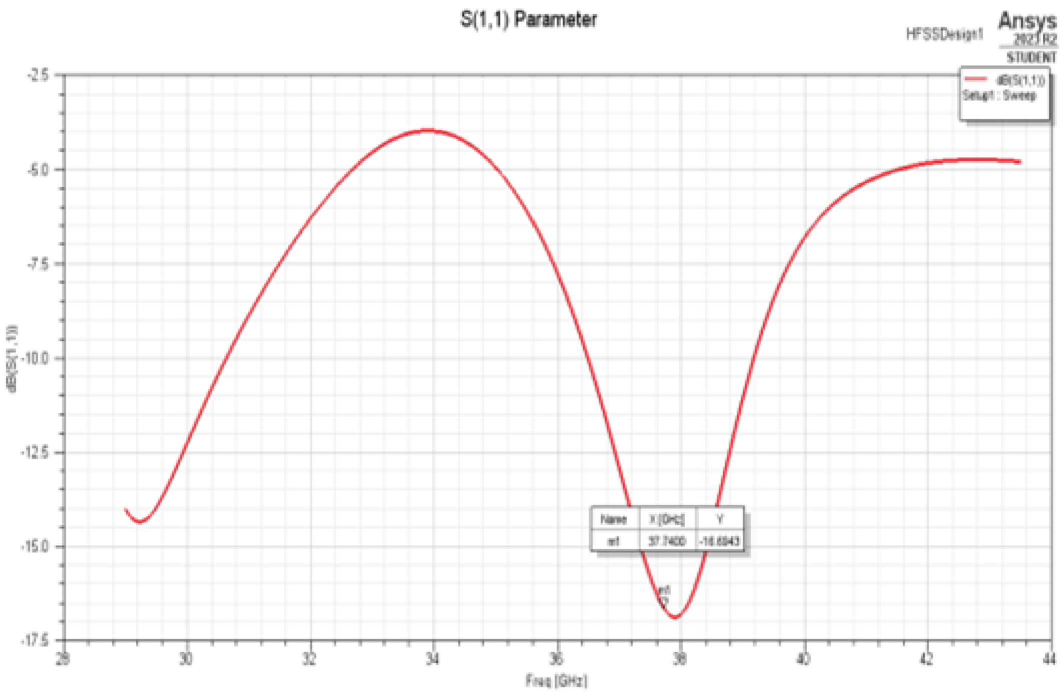


Fig 4.4.3: Return Loss of DEAF Antenna 4

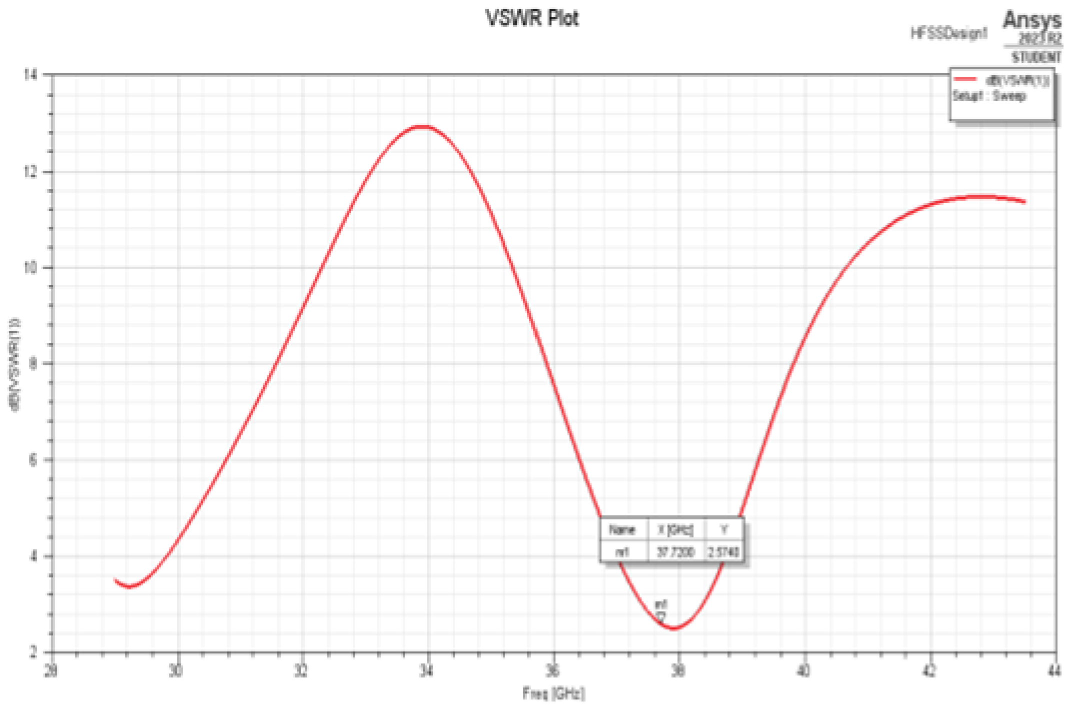


Fig 4.4.4: VSWR of DEAF Antenna 4

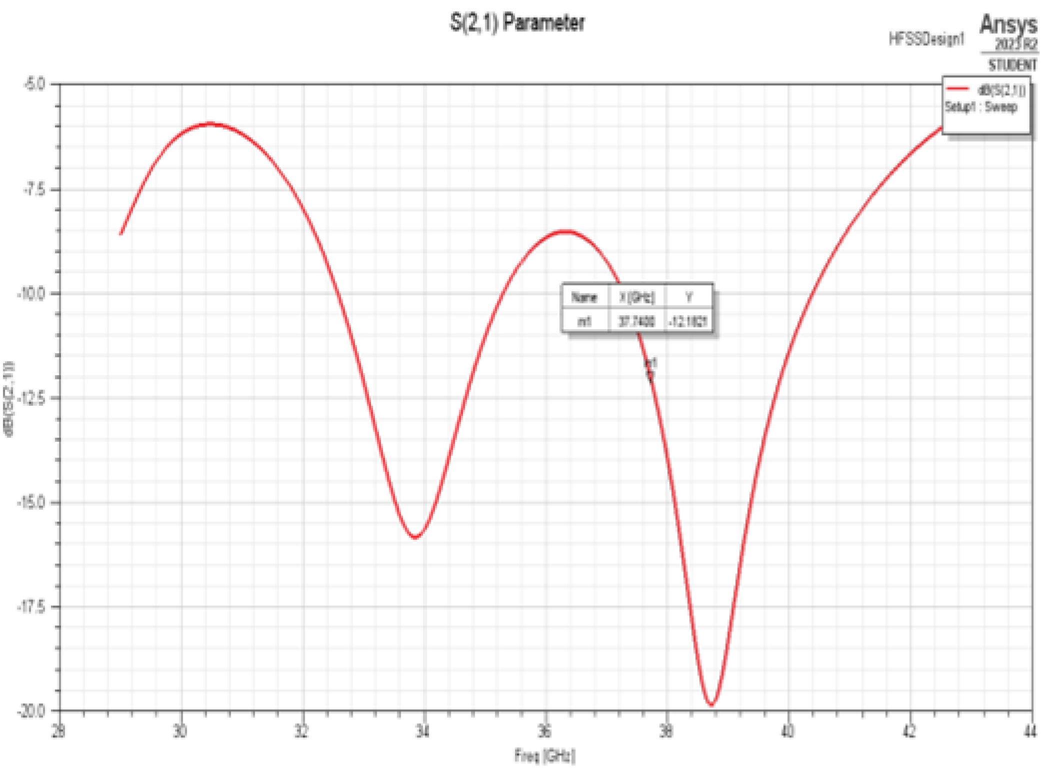


Fig 4.4.5: Transmission Gain of DEAF Antenna 4

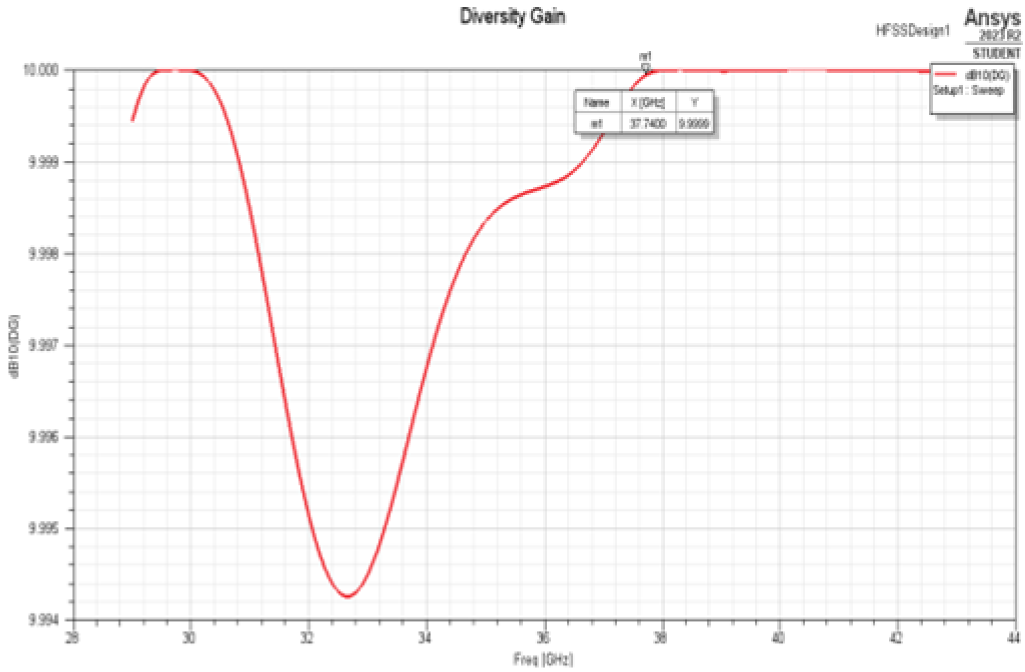


Fig 4.4.6: Diversity Gain of DEAF Antenna 4

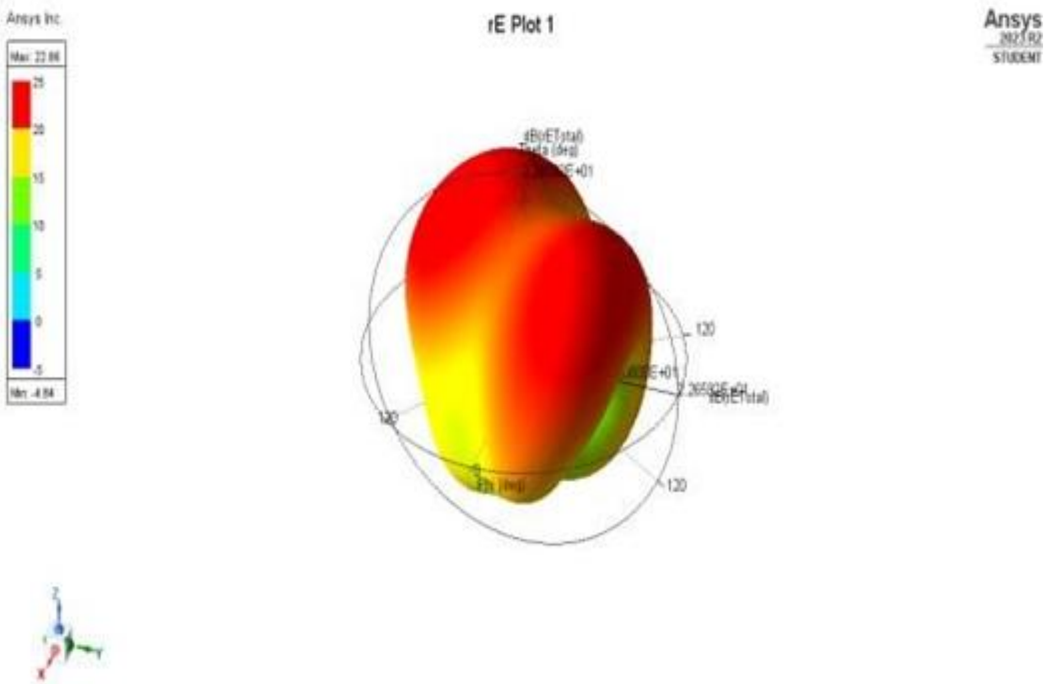


Fig 4.4.7: Gain of DEAF Antenna 4

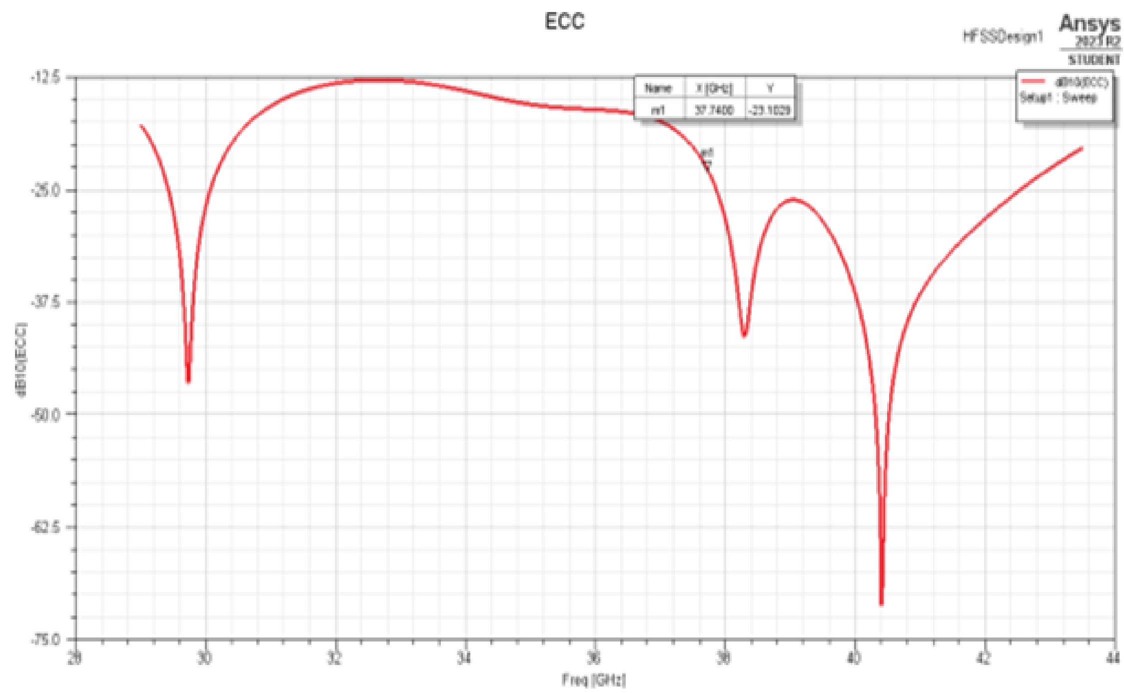


Fig 4.4.8: ECC of DEAF Antenna 4

The layout 3 and layout 4 of DEAF Antenna are having two radiating elements, also called patches are separated by a distance of λ/3 length for the operating frequency 37 GHz.

4.6 Antenna Parameters:

Analysis of various parameters like Effective Length, Effective Width, and Effective Dielectric constant.

Width of the patch:

$$\boldsymbol{W = \frac{C}{2f_0\sqrt{\frac{(\varepsilon_r + 1)}{2}}}}$$

Length of the Patch:

$$\boldsymbol{L = L_{eff} - 2\Delta L}$$

Where

W- width of the patch

C - velocity of light (3x10^11mm)

L - length of the patch

ε_r - dielectric constant of substrate

Effective length is given by:

$$\boldsymbol{L_{eff}} = \frac{\boldsymbol{C}}{\boldsymbol{2f_{0\sqrt{\varepsilon_{eff}}}}}$$

Normalized extension in length is given by:

$$\frac{\Delta \boldsymbol{L}}{\boldsymbol{h}} = \mathbf{0.412}\frac{\left(\boldsymbol{\varepsilon_{reff}} + \mathbf{0.3}\right)\left(\frac{\boldsymbol{w}}{\boldsymbol{h}} + \mathbf{0.264}\right)}{\left(\boldsymbol{\epsilon_{reff}} - \mathbf{0.258}\right)\left(\frac{\boldsymbol{w}}{\boldsymbol{h}} + \mathbf{0.8}\right)}$$

Effective Dielectric Constant:

$$\boldsymbol{\varepsilon_{reff}} = \frac{\boldsymbol{\varepsilon_r} + \mathbf{1}}{\mathbf{2}} + \frac{\boldsymbol{\varepsilon_r} - \mathbf{1}}{\mathbf{2}\sqrt{\mathbf{1} + \frac{\mathbf{12}\boldsymbol{h}}{\boldsymbol{w}}}}$$

Table2: Design Parameters of DEAF Antenna

Parameters	DEAF Antenna 1 and 2	DEAF Antenna 3 and 4
Length of the substrate	11.4mm	11.4mm
Width of the substrate	6.3 mm	6.3mm
Height of the substrate	0.8mm	0.8mm
Effective length	λ/2mm	λ/3mm
Operating frequency	29GHz	29GHz

By using the Ansoft High-Frequency Structure Simulator of version 14, each and every simulation are performed and observed.

Results And Discussions:

By using the Ansoft High-Frequency Structure Simulator of version 14, each and every simulation are performed and observed.

Return Loss:

The S parameter S_{11} represents the return loss of a device. The return loss in an antenna gives power loss in the signal when returned which is caused due to load mismatch withtransmission line impedance. The return loss value should be less than -10 dB. The below figures shows the return loss S11 of introduced antenna design.

Transmission Gain:

The S parameter S_{21} represents the transmission gain of a device. The below figures shows the transmission gain S21 of introduced antenna design.

VSWR:

Voltage standing wave ratio represents how well the device matches between source impedance and terminal impedance. The below figures shows the VSWR Plot of the DEAF Antenna.

GAIN:

Antenna gain tells us the power transmitted by antenna is a specific direction. It describes how strong a signal an antenna can send out or received is a specified direction. The below figures shows the gain plot of DEAF Antenna.

Radiation Pattern:

A radiation pattern defines the variation of power radiated by an antenna as a function of the direction away from the antenna. The radiation pattern at phi=0^0 , 90^0 is represented in the below figures for the frequency of 37 GHz.

Envelope Correlation Coefficient (ECC):

ECC is a measure of the correlation between the radiation patterns of MIMO receiving antenna pairs where it tells us how independent does the two antennas radiation patterns are. The lower ECC offers the best performance for the antenna designed. Its value ranges from 0 to 1, where 0 represents no correlation and 1 is complete correlation of the radiation patterns. Figure 6 shows the ECC plot of DEAF Antenna.

Diversity Gain:

Diversity gain is the increase in signal-to-interference ratio or how much the transmission power can be reduced when a diversity scheme is introduced, without a performance loss.

Table 2: Comparison among Antennas at 37 GHz

Parameters	**Deaf Antenna 1(λ/2)**	**Deaf Antenna 2(λ/2)**	**Deaf Antenna 3(λ/3)**	**Deaf Antenna 4(λ/3)**
Return Loss	-24.04	-22.06	-19.39	-16.69
Transmission Gain	-23.68	-14.32	-10.19	-12.18
VSWR	1.15	1.9	1.37	2.57
ECC	-39.46	-34.96	-26.89	-23.1
Diversity Gain	10.0	10.0	10.0	9.996

CONCLUSION & FUTURE SCOPE

In this project, DEAF Antenna for 5G applications using mm-wave filter is proposed. This antenna prototype is one of the ways to achieve high data capabilities for the 5G mobile applications and also for future applications like high-speed mobile network and mobile phone technologies. The main goal of this project is to design and develop 5G antenna using mm-wave filter. The basics of microstrip patch antenna are studied in detail and all the design consideration soft antenna is been examined.

The designed antenna for 5G communication showcases impressive performance metrics. With a return loss of -24dB and a VSWR of 1.15, it exhibits exceptional impedance matching and minimal signal loss. These values signify high efficiency and signal integrity, essential for reliable and high-speed data transmission in 5G networks. Overall, the antenna's design reflects meticulous engineering aimed at optimizing performance and ensuring seamless connectivity in next-generation communication systems.

According to the designing parameters the relevant feeding techniques are selected. A single microstrip patch is designed and simulated using HFSS software. The 5G antenna is designed in an operating frequency 37 GHz and simulated. The various design parameters such as return loss, VSWR, radiation pattern and gain are obtained using simulation. This simple design is achieved on a Rogers 4350 substrate which resonates at millimeter-wave frequencies of 37GHz as a unit cell. The Millimeter wave microstrip patch antenna is simulated and can be further fabricated for 5G application. 37 GHz is the most important band which is implemented for mobile phones Hence, we designed this antenna at 37 GHz frequency range for 5GApplications.

In conclusion, the designed antenna's exceptional characteristics not only fulfil the demanding requirements of 5G communication but also pave the way for transformative applications across diverse industries, driving innovation and advancing the capabilities of next-generation wireless networks.

Future Scope:

The past decade has witnessed remarkable advancements in communication technology, driving an escalating demand for miniaturization and cost-effectiveness. In response to these challenges, microstrip antenna designs have emerged as promising solutions capable of meeting stringent size and budget constraints. This paper presents a novel microstrip antenna design featuring two radiating elements with slits strategically incorporated in the radiators to achieve high isolation. Operating at a frequency of 37 GHz, the proposed antenna maintains a compact structure of 11.4 x 6.3 mm. A line feed mechanism is employed to deliver an electrical signal to the antenna patch. The choice of Rogers 4350B substrate for the antenna geometry is motivated by its exceptional characteristics, including high signal integrity, low loss, and superior performance. With a dielectric constant of 3.36 and a height of 0.8mm, Rogers 4350B substrate provides an ideal platform for circuits requiring stringent performance criteria.

Looking ahead, the future scope of this research lies in enhancing the gain of microstrip antenna designs. By focusing on further optimization techniques and innovative configurations, future iterations of microstrip antennas can strive towards achieving even higher gain levels while maintaining compact form factors and cost-effectiveness. Such advancements hold the promise of unlocking new frontiers in 5G communication, empowering the realization of diverse applications across industries and domains.

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Project Title : DEAF ANTENNA FOR MM WAVE FILTER USING HFSS

Guide Name : Dr. Dola Sanjay S., M.Tech, Ph.D

Students Nam : M. Geetha Sri Harika(20P31A0491)
B. Satish(21P35A0412)
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D. Sushma Naga Sri (20P31A0476)

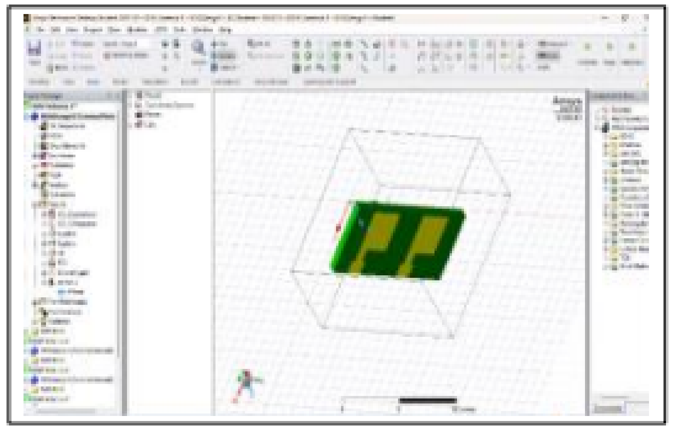
ABSTRACT	PO's Mapping	PSO's Mapping
With the advancement in communication technology over the past decade, there is an increasing demand for miniaturization and cost. The proposed design is employed with two radiating elements with slits in the radiators to produce high isolation and maintains a structure of 11.4 x 6.3 mm^2 which operates at a frequency of 37 GHz. The Line feed is used to provide an electrical signal to the patch of the antenna. Rogers 4350B substrate is used to design the proposed geometry. The dielectric constant of the Rogers 4350B substrate is 3.36 with a height of 0.8mm. The designed antenna parameters are validated using simulation software HFSS. The performance parameters like S-Parameters, VSWR, return loss, ECC, Diversity Gain and Gain are observed. The designed antenna is useful for 5G applications.	PO1 PO2 PO3 PO4 PO5 PO6 PO7 PO8 PO9 PO10 PO11 PO12	PSO1 PSO2

RELEVANCE TO PO's & PSO's :

PO1	To implement the knowledge of Antenna using software for 5G applications with minimum cost.
PO2:	To analyze the results and other parameter requirements for the antenna to get better applications.
PO3	To analyze and design the antenna using HFSS software.
PO4	Able to conclude that the proposed methodology provides result and future scope to work for better results for 5G.
PO5	To develop the model this can help in multiple factors using HFSS software.
PO8	The basic rules have been followed while developing this project.
PO9	Able to work effectively as an individual, and as a leader/member of team to get work done in specified time.
PO10	Good communication among members for better results.
PO11	The details of leadership are easily understood by students.
PO12	We will able to develop the Antenna for chosen Problem
PSO1	Related to role of design & analysis tools to solve the real time problems.
PSO2	Acquire the knowledge to design, test, verify and develop the project results.

PO1 Engineering Knowledge	PO2 Problem Analysis	PO3 Design &Development of Solution
PO4 Investigations	PO5 Modern tool usage	PO6 The Engineer& Society
PO7 Environment & Sustainability	PO8 Ethics	PO9 Individual &team work
PO10 Communication	PO11 Project Management & Finance	PO12 Life-long Learning

PSO1	PSO2
To train the students and make them industry ready in the fields of ECE and IOT	To provide well equipped laboratory infrastructure where an individual is mentored to develop innovative electronics project



CONCLUSION: In this project, DEAF Antenna for 5g applications using mm-wave filter is proposed. This antenna prototype is one of the way to achieve high data capabilities for the 5G mobile applications and also for future applications. The main goal of this project is to design and develop 5G antenna using mm-wave filter. The basics of microstrip patch antenna are studied in detail and all the design consideration soft antenna is been examined. This simple design is achieved on a Rogers 4350 substrate which resonates at millimeter-wave frequencies of 37GHz as a unit cell. The designed antenna for 5G communication shows impressive performancemetrics. With a return loss of -24dB and a VSWR of 1.15, it exhibits exceptional impedance matching and minimal signal loss. These values signify high efficiency andsignal integrity, essential for reliable and high-speed data transmission in 5G networks. Overall, the antenna's design reflects meticulous engineering aimed at optimizing performance and ensuring seamless connectivity in next-generation communication systems. In conclusion, the designed antenna's exceptional characteristics not only fulfil the demanding requirements of 5G communication but also pave the way for transformative applications across diverse industries, driving innovation and advancing the capabilities of next-generation wireless networks.