VISVESVARAYA TECHNOLOGICAL UNIVERSITY

Jnanasangama, Macche, Santibastwada Road
Belagavi-590018, Karnataka

A
UG PROJECT REPORT
on

Design & Implementation of Inset feed microstrip Antenna for 5G applications

(19EC8ICPR2)

Submitted in partial fulfillment of the requirement for the degree of

Bachelor of Engineering
in
Electronics & Communications Engineering
by

USN : 1DS20EC091 **Name: FAIZAN LONE**
USN : 1DS20EC226 **Name: U. DEVENDRA KUMAR**
USN : 1DS20EC243 **Name: Y. V. GIREESH KUMAR**
USN : 1DS21EC421 **Name: SAI SUHAS Y**

Under the guidance
of

Dr. Ninu Rachel Philip
Assistant Professor
ECE Dept., DSCE, Bengaluru

Department of Electronics & Communication Engineering
(An Autonomous College affiliated to VTU Belgaum, accredited by NBA & NAAC, Ranked by NIRF)
Shavige Malleshwara Hills, Kumaraswamy Layout,
Bengaluru-560078, Karnataka, India

2023-24

Certificate

Certified that the project work entitled "**Design and Implementation of Inset Feed Microstrip Antenna for 5G Applications**" carried out by **Lone Faizan Ahmad** (1DS20EC091)**, U. Devendra Kumar** (1DS20EC226)**, Y. V. Gireesh Kumar** (1DS20EC243)**, Sai Suhas Y** (1DS20EC421) are bonafide students of the ECE Dept. of Dayananda Sagar College of Engineering, Bangalore, Karnataka, India in partial fulfillment for the award of Bachelor of Engineering in Electronics & Communication Engineering of the Visvesvaraya Technological University, Belagavi, Karnataka during the academic year 2023-24. It is certified that all corrections/suggestions indicated for project work have been incorporated in the report deposited to the ECE department, the college central library & to the university. This final year project report **(Course Code : 19EC8ICPR2)** Phase-II has been approved as it satisfies the academic requirement in respect of project work prescribed for the said degree.

Dept. Project Coordinators (Section incharges)
Dr Abhishek – Dr Suma / Dr Manasa / Srividya / Bindu

Project Guide
Dr.Ninu Rachel Philip

Head of the Department
Dr. T.C.Manjunath, Ph.D. (IIT Bombay)

Dr. B.G. Prasad
Principal, DSCE

<u>External Project Viva-Voce</u>

Name of the project examiners (int & ext) with date :

1 : Signature : ____________________

2 : Signature : ____________________

Declaration

Certified that the project work entitled, "**Design & Implementation of Inset feed microstrip antenna for 5G applications**" with the project work course code **19EC8ICPR2** is a bonafide work that was carried out by ourselves in partial fulfillment for the award of degree of Bachelor of Engineering in Electronics & Communication Engg. of the Visvesvaraya Technological University, Belagavi, Karnataka during the academic year 2023-24. We, the students of the project group/batch no. **30** do hereby declare that the entire project work has been done on our own & we have not copied or duplicated any other's work or may be the extension of the works done by the earlier students. The results embedded in this UG project report has not been submitted elsewhere for the award of any type of undergraduate degree.

Student Name-1 : Mr. LONE FAIZAN AHMAD
USN : 1DS20EC091

Sign : ________________________

Student Name-2 : Mr. U. DEVENDRA KUMAR
USN : 1DS20EC226

Sign : ________________________

Student Name-3 : Mr. Y. V. GIREESH KUMAR
USN : 1DS20EC243

Sign : ________________________

Student Name-4 : Mr. SAI SUHAS Y
USN : 1DS21EC421

Sign : ________________________

Date : 15/05/2024

Place : Bengaluru - 560078

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Nomenclature and Acronyms

Abbreviations :

F:	Frequency
VSWR:	Voltage Standing Wave Ratio
HPBW:	Half Power Beamwidth
EIRP:	Effective Isotropic Radiated Power
SAR:	Specific Absorption Rate
dB:	Decibels
L:	Length
W:	Width
H:	Height
G:	Gap
S:	Spacing
UWB:	Ultra-Wideband
EM:	Electromagnetic
RF:	Radio Frequency
PCB:	Printed Circuit Board
SMA:	Subminiature version A (connector)
AR:	Axial Ratio
BW:	Bandwidth
HP:	Half-Power

Acronyms (Alphabetical Order) :

A:	Aperture area
c:	Speed of light
E:	Electric field strength
G:	Antenna gain
H:	Magnetic field strength
I:	Current
λ:	Wavelength
η:	Efficiency
P:	Power
R:	Radiation pattern
V:	Voltage
Z:	Impedance
θ, φ:	Spherical coordinates (theta, phi)

Abstract

The project aims to design and implement an inset feed antenna suitable for 5G applications, focusing on efficient operation in the millimeter-wave spectrum (~30 GHz). Using ANSYS software Student Version 2023, the student will simulate and optimize the antenna design, considering parameters such as substrate material, patch dimensions, feed location, and matching network design. The goal is to achieve high efficiency and performance within the designated 5G frequency bands.

The implementation phase will involve translating the optimized design into a practical antenna prototype. The student will focus on ensuring that the fabricated antenna closely matches the simulated design. This phase will also include validating the antenna's performance through simulation, without physical testing. Through this project, the student will gain valuable experience in antenna design and simulation, specifically for 5G applications, and enhance their proficiency in using ANSYS software for RF and microwave engineering projects.

The project's focus on designing and implementing an inset feed antenna for 5G applications is particularly relevant in the context of the Internet of Things (IoT). 5G technology is crucial for enabling the massive connectivity and high data transfer speeds required by IoT devices. The millimeter-wave spectrum, around 30 GHz, is especially important for 5G IoT applications as it offers increased bandwidth and capacity, allowing for the simultaneous connection of a large number of devices.

By designing an antenna optimized for 5G, the project directly addresses the need for efficient and reliable communication in IoT systems. The use of ANSYS software Student Version 2023 for simulation and optimization ensures that the antenna meets the stringent requirements of 5G IoT applications, such as low latency, high reliability, and energy efficiency. The project's implementation phase, focusing on translating the optimized design into a practical prototype, will demonstrate the antenna's suitability for real-world IoT deployments.

Keywords : Millimeter-wave , Inset feed, spectrum, ANSYS software,HFSS,VSWR,S-Parameter

Chapter-1

Introduction

In the area of wireless communication, the evolution of antenna technology stands as a testament to humanity's relentless pursuit of connectivity and innovation. From the pioneering experiments of Heinrich Hertz, which served to validate James Clerk Maxwell's groundbreaking electromagnetic wave theory, to the contemporary landscape of ubiquitous 5G networks, antennas have played a pivotal role in shaping the way we communicate and interact with the world around us.The journey of antenna development has been marked by a series of transformative milestones, each building upon the successes and insights of its predecessors. In the 1920s, the emergence of the Yagi-Uda antenna, developed by Japanese innovator Shintaro Uda, revolutionized long-distance radio communication with its remarkable gain and effectiveness. Subsequently, the advent of Horn antennas in the 1930s ushered in an era of minimal loss, superior directivity, and enhanced gain, finding widespread application during the tumultuous years of World War II.

However, it was in the post-war period that a new chapter in antenna design began to unfold. In 1953, the inception of microstrip antennas, also known colloquially as "patch antennas," laid the foundation for a paradigm shift in antenna engineering. Initially underexplored, their potential surged with the widespread adoption of printed circuit boards (PCBs) in the 1970s, leading to their integration across diverse domains from aerospace to telecommunications.

The appeal of microstrip antennas lies in their inherent advantages: their low-profile design, ease of fabrication, and compatibility with modern electronic systems. Yet, despite their widespread use, challenges persist, with impedance matching standing out as a critical factor in maximizing power transfer efficiency between the antenna and its associated circuitry.

To address this challenge, innovative techniques have been devised, among which the inset feed methodology has emerged as a compelling solution. By strategically introducing an inset cut in the patch, this technique facilitates precise alignment of the feed line's impedance with that of the patch, thereby optimizing performance without resorting to cumbersome external circuitry. This elegant solution not only simplifies the design and fabrication process but also enhances the antenna's operational efficiency and effectiveness in real-world applications.

Against this backdrop of historical innovation and contemporary challenges, this project embarks on a journey to design and implement an Inset Feed Microstrip Antenna tailored explicitly for 5G applications.

Drawing inspiration from the rich tapestry of antenna engineering history, this endeavor seeks to push the boundaries of possibility, marrying theoretical insights with practical engineering expertise to forge a path towards the realization of robust, high-speed, and reliable 5G communication systems Through meticulous simulation, prototyping, and experimentation, this project endeavors to demonstrate the efficacy and viability of the proposed antenna design in meeting the demanding requirements of modern wireless communication infrastructures. By harnessing the power of innovation and collaboration, we aspire to leave an indelible mark on the ever-evolving landscape of antenna engineering, contributing to a future where seamless connectivity knows no bounds.

1.1 Overview of the project work:

The project revolves around crafting and deploying an Inset Feed Microstrip Antenna optimized for 5G applications. It draws inspiration from the historical trajectory of antenna development, tracing its roots from Heinrich Hertz's foundational experiments to the contemporary realm of wireless communication networks. The primary goal is to tackle impedance matching challenges inherent in antenna design by employing the strategic inset feed technique.

Informed by the diverse landscape of antenna engineering, the project aims to blend theoretical insights with practical engineering prowess. Through systematic simulation, prototyping, and rigorous experimentation, it endeavors to showcase the effectiveness and feasibility of the proposed antenna design in meeting the complex demands of modern wireless communication infrastructures.

By embracing innovation and fostering collaborative efforts, the project aspires to make significant contributions to the ever-evolving field of antenna engineering, envisioning a future where seamless connectivity knows no bounds.

1.2 Background information about the project work:

Antenna technology has evolved significantly over the years, enabling the advancement of wireless communication systems. From Heinrich Hertz's experiments to the era of 5G networks, antennas have been pivotal in transmitting and receiving electromagnetic signals.Microstrip antennas, introduced in 1953 and popularized in the 1970s, revolutionized antenna design with their low-profile form and compatibility with modern electronic systems.

However, challenges such as impedance matching persist.To address these challenges, innovative techniques like the inset feed methodology have emerged. This approach, involving strategic cuts in the patch, improves antenna efficiency without additional circuitry.In this project, we aim to design and implement an Inset Feed Microstrip Antenna for 5G applications. Drawing on historical insights and modern engineering, we seek to demonstrate the effectiveness of this antenna design in meeting the demands of contemporary wireless communication systems.

Through simulation and experimentation, we aim to contribute to the ongoing evolution of antenna technology, paving the way for enhanced connectivity and innovation in the 5G era.

1.3 Motivation obtained to take up the project work:

The motivation driving this project springs from a deep-seated intrigue at the intersection of antenna engineering and the forefront of communication technologies. As the landscape of wireless communication undergoes rapid evolution, catalyzed by the advent of 5G networks and beyond, the demand for innovative antenna solutions capable of meeting escalating connectivity needs becomes increasingly pressing.

The allure of immersing oneself in the design and implementation of an Inset Feed Microstrip Antenna tailored for 5G applications lies in the opportunity it presents to actively contribute to the ongoing narrative of technological advancement. Through a comprehensive exploration of antenna design intricacies, particularly in navigating impedance matching challenges and adapting to emerging communication standards, there exists the potential to carve out new frontiers in wireless communication technology.Furthermore, the prospect of seamlessly bridging theoretical insights with practical engineering applications not only poses an exhilarating challenge but also serves as a catalyst for personal and professional growth. Embracing this project offers a platform for hands-on experience in simulation, prototyping, and experimentation, culminating in the development of a tangible solution with palpable real-world impact.

Ultimately, the driving force behind undertaking this endeavor is a deeply ingrained passion for innovation, an unyielding commitment to exploration within the realm of antenna engineering, and a steadfast dedication to driving forward the evolution of wireless communication technology for the collective betterment of society.

1.4 Problem statement of the project work:

The challenge at hand involves optimizing the design of an Inset Feed Microstrip Antenna tailored for 5G applications, with a primary focus on achieving efficient impedance matching between the antenna and its associated circuitry. This necessitates overcoming common hurdles encountered in conventional antenna designs, such as limited bandwidth, suboptimal efficiency, and less-than-ideal radiation characteristics.

The objective is to leverage simulation tools to explore a range of design parameters and configurations, with the aim of enhancing the antenna's performance metrics while aligning with the stringent requirements imposed by 5G communication standards. This entails a specific emphasis on fine-tuning the antenna's impedance matching to maximize power transfer efficiency and minimize signal loss.

Once promising design candidates are identified through simulations, the subsequent phase involves validating their performance through real-world experiments. This entails the fabrication of antenna prototypes and subjecting them to comprehensive testing within controlled laboratory settings. Through meticulous experimentation, the goal is to validate the findings from simulations and evaluate the antenna's real-world performance across diverse operating conditions.By addressing this problem statement, the project aims to develop an Inset Feed Microstrip Antenna optimized for 5G applications, validated through a combination of simulation- based design exploration and real-world experimentation. This endeavor not only contributes to the advancement of antenna technology but also holds broader implications for the enhancement of wireless communication systems.

1.5 Objectives of the project work:

1. Design Optimization: We aim to delve into the intricacies of antenna design, exploring various parameters and configurations to tailor the Inset Feed Microstrip Antenna for optimal performance in 5G environments.
2. Impedance Matching: Our focus is on ensuring that the antenna seamlessly integrates with its surrounding circuitry, maximizing power transfer efficiency and minimizing signal loss through meticulous attention to impedance matching.
3. Simulation Analysis: By harnessing the power of simulation tools, we seek to gain deep insights into the antenna's behavior under different conditions, paving the way for informed design decisions and performance predictions.
4. Prototype Fabrication: We'll bring our designs to life by fabricating antenna prototypes, taking into account real-world constraints and manufacturing considerations to ensure practical feasibility.
5. Real-Time Experimentation: Through hands-on experimentation in controlled laboratory settings, we'll validate the performance of our antenna prototypes, grounding our theoretical insights in real-world scenarios.
6. Performance Evaluation: Our journey doesn't end with simulations and prototypes; we'll rigorously evaluate the real-world performance of our antennas, comparing experimental results with simulation predictions to validate our designs.
7. Optimization Iteration: Armed with insights from experimentation, we'll continuously refine our designs, iterating on the optimization process to further enhance the antenna's performance and robustness.
8. Documentation and Reporting: Every step of our project will be meticulously documented, ensuring that our findings are captured in a comprehensive project report for transparency and knowledge sharing.

9. Knowledge Dissemination: We're committed to sharing our learnings and insights with the wider community through presentations, publications, and other avenues, contributing to the collective pool of knowledge in antenna engineering.

10. Future Directions: Looking ahead, we'll identify promising paths for future research and development, leveraging the lessons learned from our project to drive innovation and advancement in antenna technology.

1.6 Scope of the project work:

Scope of the project work for Design and Implementation of Microstrip inset feed patch antenna for 5G application typically include:

1. **Advancing 5G Technology:** Our project aims to optimize the design of Inset Feed Microstrip Antennas for 5G applications, contributing significantly to the ongoing evolution of 5G technology. By enhancing antenna performance and efficiency, our goal is to enable faster data transmission, improve network reliability, and extend coverage, thereby enhancing the overall 5G experience for users.

2. **Enabling Connectivity in Remote Areas:** Through the deployment of optimized antennas, we seek to extend the reach of 5G networks to underserved and remote areas. This initiative aims to bridge the digital divide by providing access to high- speed internet connectivity, which holds immense potential for socioeconomic development, education, healthcare, and other essential services in these regions.

3. **Supporting IoT and Smart Cities:** The outcomes of our project have the potential to drive the proliferation of IoT devices and facilitate the development of smarter, more connected urban environments. Optimized antennas play a crucial role in enabling seamless communication between IoT devices and supporting the deployment of smart city infrastructure, leading to improved efficiency and quality of life for urban residents.

4. **Enhancing Communication in Critical Situations:** Reliable communication is essential in emergency and disaster scenarios for effective coordination, response, and rescue operations. Through the deployment of robust antenna systems, our project aims to enhance communication reliability and performance, potentially saving lives in critical situations.

5. **Driving Innovation in Antenna Engineering:** The optimization techniques and design principles developed through this project can be applied across various antenna systems, spanning different frequency bands, communication standards, and use cases, thereby driving progress in the field.

Chapter 2

Literature Survey

In recent years, the demand for high-performance wireless communication systems has surged dramatically. This surge is primarily driven by the widespread adoption of mobile devices, the rapid expansion of IoT applications, and the emergence of advanced technologies such as 5G. Consequently, there has been a notable increase in research efforts aimed at exploring innovative antenna designs and configurations. The ultimate goal of these endeavors is to enhance the efficiency, reliability, and coverage of wireless networks to meet the growing demands of modern connectivity.

[1] In their paper titled "Design of Microstrip Patch Antenna for High-Quality Online Education and 5G Applications at 26 GHz,IEEE 2020" the authors address the need for uninterrupted high-speed online education, particularly in developing countries like India. They propose a microstrip patch antenna designed for 5G millimeter wave bands, operating at 26 GHz. The antenna design includes a rectangular patch with a dielectric constant of 2.2 and a dielectric loss tangent of 0.0010. Using FEKO software for simulation and analysis, the authors achieved impressive results, including a return loss of -33.4 dB, a bandwidth of 3.56 GHz, VSWR less than 2, a high gain of 10 dB, and an antenna radiation efficiency of 99.5%. This design is particularly advantageous during the ongoing global lockdown, offering reliable high-speed connectivity for online education and other 5G applications.

[2] Indonesian Journal of Electrical Engineering and Computer Science in January 2020 investigated the utilization of microstrip array antennas with inset-fed for WLAN applications. This study shed light on the potential advantages of array antennas, emphasizing their ability to improve key performance metrics such as gain, directivity, and signal quality. By doing so, these antennas have the potential to significantly enhance the overall efficiency of wireless communication systems. However, the study also underscored concerns regarding the power consumption associated with array antennas. This highlighted the critical importance of meticulous design and configuration to mitigate potential energy inefficiencies.

[3] Another significant research endeavor, undertaken by the National Engineers School of Sfax Laboratory of Electronics and Technology of Information (LETI) in March 2016 focused on the design of rectangular microstrip patch antennas. This study emphasized the compact size of these antennas, making them particularly suitable for applications where space is limited, such as mobile devices and small IoT sensors. Despite their compact nature, the study revealed that rectangular patch antennas are susceptible to environmental factors, such as nearby objects, which can have a substantial impact on their performance and reliability. Consequently, the study emphasized the necessity of taking environmental factors into account during the design and deployment of microstrip patch antennas.

[4] Furthermore, a study conducted by Madhukant Patel in 2019 delved into the design and analysis of microstrip patch antenna arrays for X-Band applications. Patch antenna arrays offer the significant advantage of high gain, rendering them well-suited for long- range communication applications. However, the study also highlighted the inherent complexity associated with designing and implementing patch antenna arrays with a corporate feed network. This complexity necessitates specialized knowledge and expertise. Nevertheless, despite these challenges, the study emphasized that the high gain achieved by patch antenna arrays makes them a compelling choice for applications requiring extended coverage and reliability.

[5] Additionally, a study published in 2015 by Santosh B. Patil, focused on the design and performance analysis of inset feed microstrip square patch antennas for 2.4GHz wireless applications. This study highlighted the ease of integration of these antennas into printed circuit boards (PCBs), thereby reducing the overall footprint of wireless devices. The compact size and seamless integration of inset feed microstrip square patch antennas make them highly versatile, catering to a wide range of wireless applications, including WiFi routers, IoT devices, and wireless sensors.

Chapter 3

Project Details

3.1 Block diagram of the proposed system:

The block diagram of “Design and Implementation of Microstrip inset feed patch antenna for 5G application” is as follows:

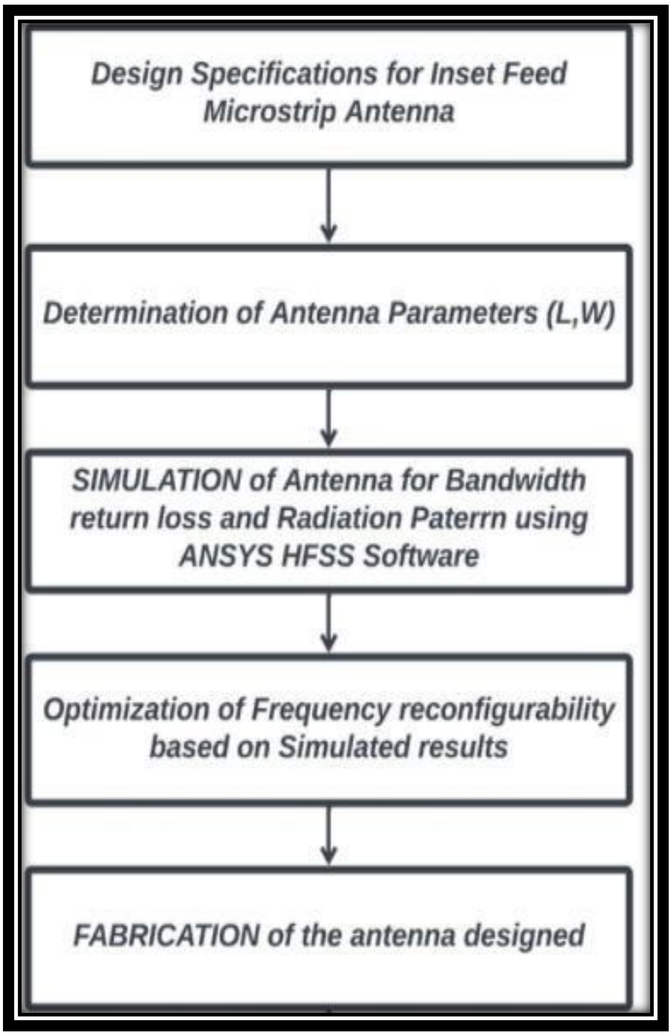

Fig 1: Block-diagram of the proposed methodology

- **Design Specifications for Inset Feed Microstrip Antenna:**In crafting the specifications for an Inset Feed Microstrip Antenna, key parameters demand clarity to ensure its effectiveness. Firstly, defining the operating frequency range, like 2.4 GHz for Wi-Fi, sets the antenna's compatibility. Then, specifying desired bandwidth and gain ensures optimal performance. Next, selecting substrate material properties, such as dielectric constant and thickness, directly influence antenna characteristics. Finally, determining antenna shape and dimensions, whether square or rectangular, shapes radiation pattern and impedance matching.

These specifications collectively lay the groundwork for an efficient and tailored antenna design, integral to seamless integration within wireless communication systems.

- **Determination of Antenna Parameters (L, W):** In the process of determining the parameters for the Inset Feed Microstrip Antenna, specifically the length (L) and width (W) of the patch, certain steps are pivotal. Initially, it involves calculating the patch dimensions, aligning them with the desired operating frequency and substrate properties. This calculation takes into account factors like the dielectric constant of the substrate material, influencing the electrical characteristics of the antenna. Additionally, it's essential to consider the feed location and type, such as inset feed, to ensure proper impedance matching. The placement and design of the feed mechanism play a crucial role in optimizing the antenna's performance and aligning it with the desired specifications. By meticulously determining these parameters, the antenna can be tailored to meet the requirements of the specific communication system, ensuring efficient operation and seamless integration.

- **Simulation of Antenna for Bandwidth, Return Loss, and Radiation Pattern using ANSYS HFSS Software:** In the ANSYS HFSS software ecosystem, the simulation of the Inset Feed Microstrip Antenna unfolds as a methodical voyage. Beginning with the meticulous configuration of the antenna's geometry and material properties, a robust foundation is established within the simulation realm. Subsequent simulations delve deep into scrutinizing critical performance metrics such as bandwidth, return loss, and radiation pattern, offering invaluable insights into the antenna's operational prowess. Through iterative optimization endeavors, the design undergoes a process of refinement, guided by the nuanced feedback gleaned from simulations. This iterative journey, characterized by continuous adjustments and enhancements, culminates in a finely tuned antenna design that seamlessly aligns with performance specifications, epitomizing the synergy between simulation and real- world application.

- **Optimization of Frequency Reconfigurability based on Simulated Results:** In the pursuit of optimizing the antenna's frequency reconfigurability based on simulated results, a strategic approach is essential. Firstly, it involves exploring potential design modifications aimed at enabling frequency reconfigurability, if deemed necessary. This entails assessing various antenna parameters to understand their impact on resonance frequency and bandwidth. Subsequently, leveraging simulation results becomes pivotal in adjusting antenna parameters to achieve optimal performance across different frequencies. These adjustments ensure the antenna's adaptability to varying frequency bands, enhancing its versatility. Furthermore, rigorous verification through simulations is conducted to validate the antenna's reconfigurability and ensure alignment with desired specifications. Through this systematic process, the antenna can be finely tuned to meet the dynamic demands of modern communication systems, offering efficient performance across a range of operating frequencies.

- **Fabrication of the Antenna Designed:**In the fabrication phase of the antenna designed, a meticulous process is essential to translate the optimized design into a physical prototype. Initially, the optimized antenna design parameters are translated into a tangible form, considering factors such as dimensionality and material properties. Next, appropriate fabrication techniques are selected based on the antenna design and substrate material. This may involve methods such as PCB etching for planar antennas or 3D printing for complex geometries. Once the fabrication techniques are determined, the antenna components are assembled according to the design specifications, ensuring precise alignment and adherence to the intended geometry. This meticulous approach to fabrication ensures that the physical prototype accurately reflects the optimized antenna design, laying the foundation for comprehensive testing and validation.

3.2 Design of the proposed system:

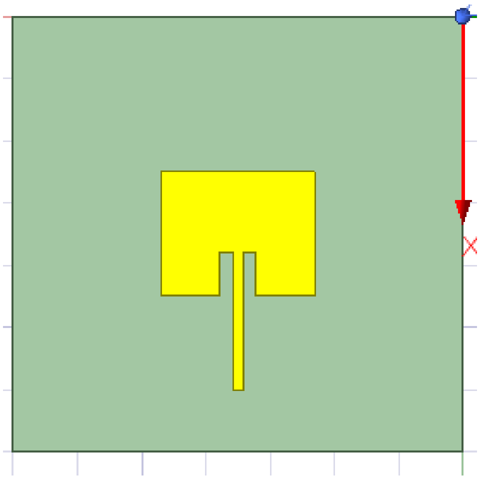

Fig 2 : Top view of Design

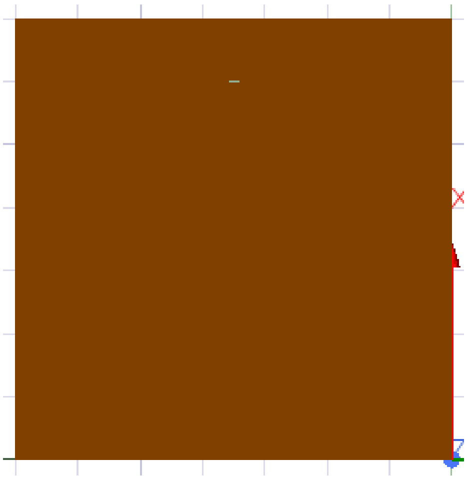

Fig 3:Bottom view of Design

The design of the proposed system revolves around the development of a microstrip inset feed patch antenna, renowned for its compactness and efficiency in wireless communication applications. At its core, this design features a meticulously crafted patch made of conducting material, typically configured in either a square or rectangular shape, strategically positioned atop a dielectric substrate. Fig 2, for instance, offers a top-down view, showcasing the precise configuration of the patch antenna atop the dielectric substrate. This illustration allows viewers to visualize the dimensions and placement of the radiating patch, which serves as the core component facilitating signal transmission and reception. Serving as the antenna's radiating element, this patch facilitates the transmission and reception of electromagnetic signals.Critical to the antenna's performance is the selection of an appropriate substrate material, with commonly used options including FR-4 or Rogers, chosen for their favorable dielectric properties and mechanical stability.

The dimensions of both the patch and substrate are meticulously determined based on the desired operating frequency and specific performance objectives. Additionally, the implementation of an inset feed mechanism ensures optimal impedance matching between the transmission line and the radiating patch.

Fig 3 presents a bottom-up perspective, revealing the intricate layout of the ground plane without the patch visible. Here, observers can discern the strategic integration of features such as apertures and rectangular slots designed to optimize antenna performance. The ground plane of the antenna is carefully designed to complement the radiating patch, with features such as apertures and rectangular slots strategically incorporated to enhance performance parameters like impedance matching and radiation efficiency. Through iterative design iterations and simulations, the antenna's geometry and parameters are optimized to meet stringent performance requirements across a range of operating conditions.

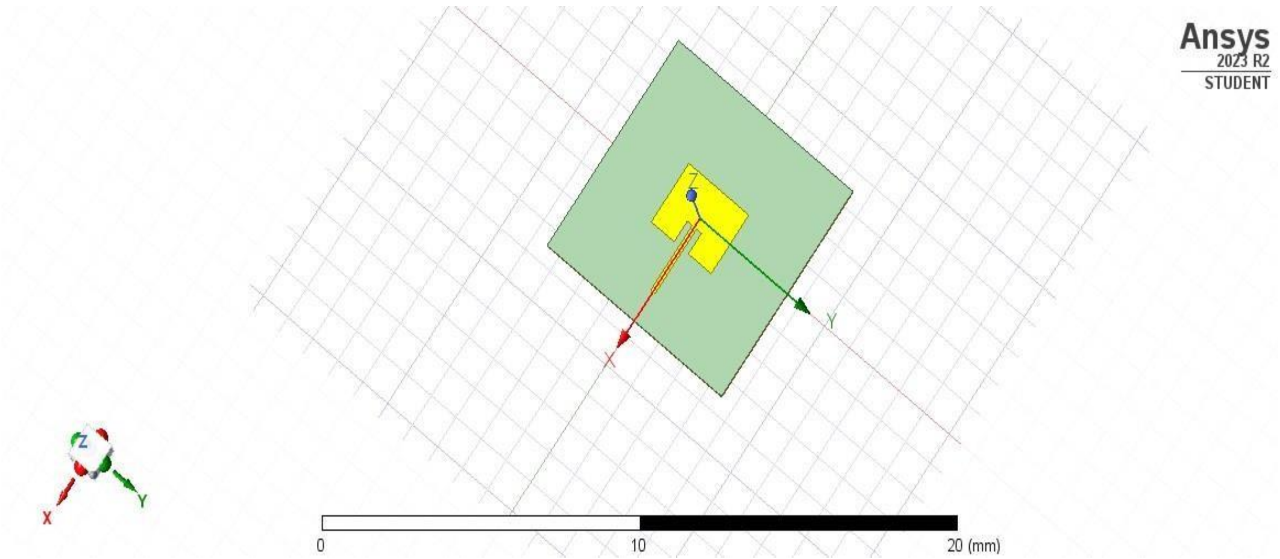

Fig 4 D:esign in ANSYS Software

The ANSYS picture illustrates the intricate design of the microstrip inset feed patch antenna, showcasing key components such as the radiating patch, dielectric substrate, and ground plane. The radiating patch, meticulously crafted from conducting material, serves as the core element for transmitting and receiving electromagnetic signals, strategically positioned atop the dielectric substrate. Surrounding the patch, the substrate provides mechanical support and insulation, chosen for its favorable electrical properties. The ground plane, intricately designed to complement the patch, features apertures and rectangular slots aimed at enhancing performance parameters like impedance matching and radiation efficienc

3.3 Flow-chart For Designing the Antenna:

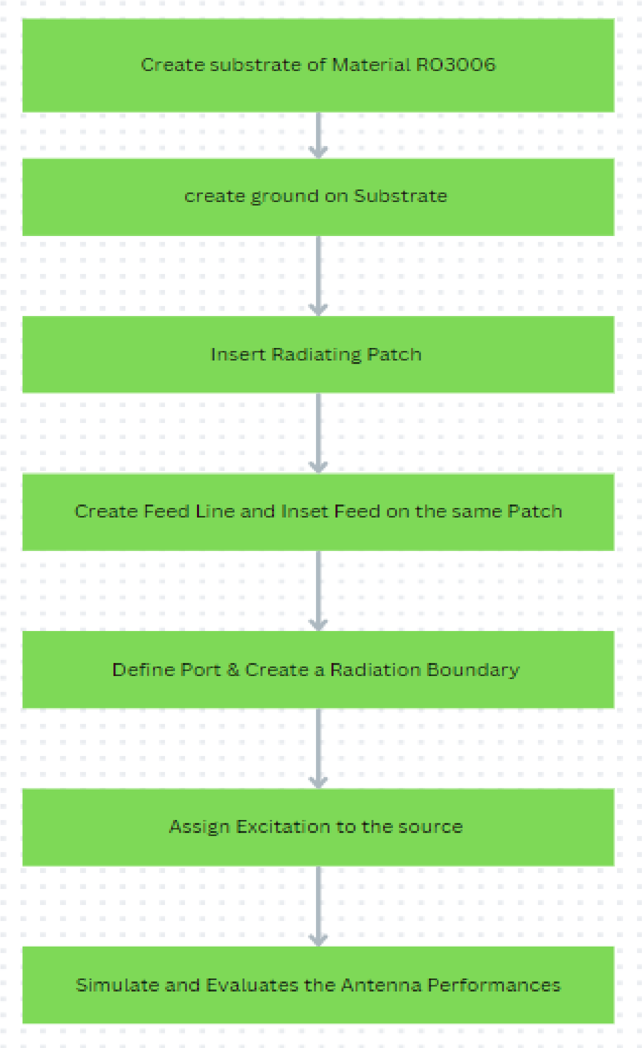

Fig 5 : Design steps

1. **Set Up Design Parameters:** In the initial phase of patch antenna design, meticulous attention is given to establishing crucial parameters under the "Set Up Design Parameters" step. This involves defining the precise working frequency range, ensuring alignment with application requirements and regulatory standards. Substrate material properties, including dielectric constant and thickness, are carefully characterized, considering their significant impact on antenna performance. Additionally, dimensions of the patch antenna and inset feed line are determined with precision, aiming for optimal impedance matching and radiation efficiency. This foundational step lays the groundwork for subsequent stages of antenna design and optimization, enabling the creation of a tailored patch antenna solution.

2. **Create the Substrate:** The first step in the design process within HFSS is to create the substrate for the patch antenna. This is accomplished by drawing a rectangle on the HFSS layout, representing the physical dimensions of the substrate. Careful consideration should be given to accurately define the substrate's dimensions, aligning with the desired specifications for the patch antenna. Once the substrate shape is created, the next crucial aspect is to define the material properties of the substrate within the HFSS material library. This involves specifying parameters such as dielectric constant, loss tangent, and thickness, which profoundly influence the electromagnetic behavior of the substrate. By accurately defining these material properties, HFSS ensures precise simulation and analysis of the patch antenna's performance characteristics.

3. **Create the Patch Antenna:** To initiate the creation of the patch antenna within HFSS, the first step is to draw a rectangle on the substrate layout, representing the physical dimensions of the patch. This rectangle serves as the radiating element of the antenna and must be sized and shaped appropriately to meet performance requirements. Subsequently, the dimensions of the patch are specified based on predefined design parameters, ensuring alignment with desired operating frequencies and impedance matching criteria. Once the patch dimensions are established, the material properties of the patch are assigned from the HFSS material library, encompassing parameters such as dielectric constant and conductivity. Accurately defining these material properties enables HFSS to conduct precise simulations and analysis of the patch antenna's electromagnetic behavior.

4. **Create the Inset Feed Line:** To create the inset feed line in HFSS, the process begins by drawing a line extending from the edge of the patch to the specified feed point on the patch itself. This line acts as the transmission pathway, delivering RF energy to the patch antenna for its operation. Subsequently, it's imperative to meticulously specify the width and length of the feed line based on the predefined design parameters. The width of the feed line significantly influences impedance matching and signal transmission efficiency, while the length dictates electrical delay and phase characteristics. Therefore, careful consideration is essential to ensure that these dimensions align precisely with the desired operating frequency and impedance matching requirements of the antenna system. By adhering to these detailed steps, HFSS enables accurate simulation and analysis of the antenna's electromagnetic behavior, ensuring optimal performance.

5. **Define Ports:** To thoroughly define ports in HFSS, a meticulous two-step process is undertaken. Initially, a port is specified at the termination point of the feed line, acting as the primary excitation source for the antenna. This port serves to inject RF energy into the system, initiating the antenna's electromagnetic response. Subsequently, another port is established on the opposing side of the patch to replicate the presence of the ground plane.

This additional port provides a comprehensive reference plane for the antenna's operation, facilitating an accurate depiction of its interaction with the surrounding environment. Through the meticulous definition of these ports, a comprehensive analysis of the antenna's radiation pattern and impedance characteristics can be conducted, enabling a thorough evaluation of its performance under varying operational conditions.

6. **Meshing:** The meshing stage is critical for accurately representing the geometry of the entire structure in HFSS. A mesh is generated to cover the antenna, substrate, and surrounding components. It is essential to ensure that the mesh is fine enough to capture the intricate features of the antenna accurately. A fine mesh resolution is necessary to capture details such as the curvature of the patch, the intricacies of the feed line, and any other geometric nuances present in the design. By generating a fine mesh, the simulation results will be more accurate, providing a detailed insight into the antenna's performance characteristics.

7. **Setting Boundary Conditions:** To ensure accurate simulation results in HFSS, setting appropriate boundary conditions is imperative. Firstly, boundary conditions are applied to the edges of the substrate and the ground plane to simulate infinite boundaries effectively. This helps to mimic the behavior of the antenna in an unbounded environment, preventing unwanted reflections and ensuring accurate analysis of its radiation characteristics. Secondly, the excitation port is defined with the appropriate voltage or current source for simulation. This step is crucial as it specifies how the antenna is excited, allowing for the assessment of its performance under realistic operating conditions. By meticulously defining these boundary conditions, the HFSS simulation accurately replicates the antenna's behavior and provides valuable insights into its electromagnetic performance.

8. **Simulation Setup:** During this phase, critical parameters are configured in HFSS to ensure accurate analysis. This includes setting up the simulation parameters such as defining the frequency range, selecting solver settings, and establishing convergence criteria. The frequency range determines the span over which the antenna's performance will be evaluated, while solver settings dictate the numerical algorithms used to solve Maxwell's equations. Convergence criteria are defined to ensure reliable simulation results by specifying thresholds for solution accuracy. Subsequently, the simulation is executed to compute the antenna's performance parameters, including return loss, impedance matching, and radiation pattern. Return loss quantifies the amount of power reflected from the antenna, impedance matching evaluates the agreement between the antenna and its feedline, and the radiation pattern characterizes how the antenna emits electromagnetic energy in space. Through meticulous simulation setup and execution, HFSS enables comprehensive analysis of the antenna's behavior and performance.

3.4 Design Specifications:

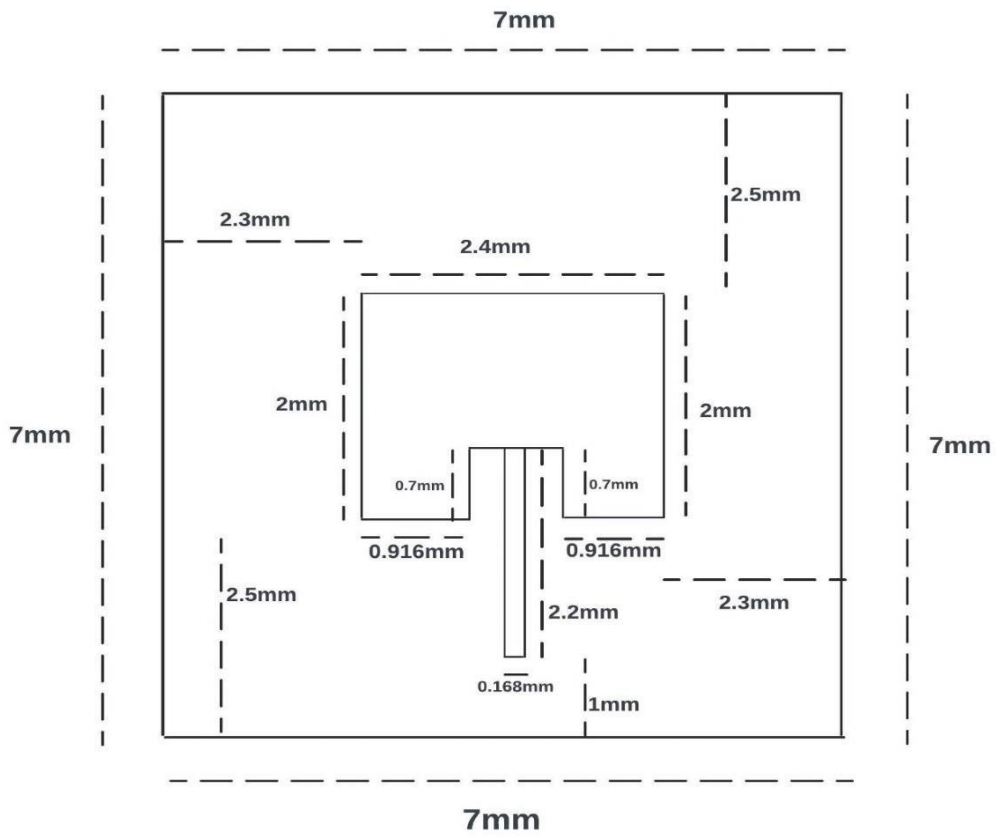

Fig 6 : Design Dimension

Designing a microstrip inset feed antenna, several key parameters need to be considered to ensure optimal performance.

Parameters Micro-strip Patch Antenna With Inset-Fed Operating:

Frequency 29.8 GHz	Dielectric Constant er = 6.15
Material used for Substrate: Rogers RO3006(tm)	Material used for patch and Ground: Copper
Dielectric Height (h): 0.16 mm	Substrate Dimension :7mm*7mm
Feedline length: 2.2mm	Patch Length (L): 2.4 mm
Width (W): 2 mm	Input Impedance (Edge): 321 ohm

Table 1:Design Parameters

3.5 Mathematical Calculations:

The design of a microstrip patch antenna relies on the following equations. First, we have an effective dielectric constant for a given PCB substrate Dk =6.15, which then determines the width and length of the patch for a given operating frequency. The design process goes as follows:

1.Select an operating frequency (f0)

2. Calculate the patch width (W) using the substrate dielectric constant (Dk) and thickness (h)
3. Calculate an effective dielectric constant
4. Calculate the patch length (L) using results from Steps 2 and 3.

$$\varepsilon_{eff} = \frac{\varepsilon_R+1}{2} + \frac{\varepsilon_R-1}{2}\left[\frac{1}{\sqrt{1+12\left(\frac{h}{W}\right)}}\right] \quad \text{---------(1)}$$

$$W = \frac{c}{2f_o\sqrt{\frac{\varepsilon_R+1}{2}}} \quad \text{---------2)}$$

$$L = \frac{c}{2f_o\sqrt{\varepsilon_{eff}}} - 0.824h\left(\frac{(\varepsilon_{eff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\varepsilon_{eff}-0.258)\left(\frac{W}{h}+0.8\right)}\right) \quad \text{----------(3)}$$

5.Calculation of position of inset feed point where the input impedance is 50 ohms.

$$Y_0 = \frac{L}{\pi}\cos^{-1}\left(\sqrt{\frac{Z_{in}}{R_{in}}}\right) \quad \text{----------(4)}$$

Where, Zin and Rin is the resonant input impedance and resonant input resistance respectively. The Y0 is found to be 7 mm.

Substrate selection At frequency of 29.8GHz for better input impedance :

Substate material	Dielectric constant	Length	Width	Input Impedance
FR4	4.4	2.35mm	3.06mm	243 ohm
RO 4003	3.55	2.61mm	3.32mm	204 ohm
RO 3003	3	2.84mm	3.55mm	180 ohm
RO 3006	6.15	2mm	2.4mm	321 ohm
RT DUROID	2.33	3.22mm	3.90mm	149 ohm

Table 2: Substrate selection

ROGERS RO 4003 VS ROGERS RO 3006 (L,W) comparison :

Substrate material	length	width	Input impedance	Resonant frequency
RO 4003	3mm	3mm	325 ohm	26.1 GHz
RO 4003	4mm	4mm	322 ohm	19.8 GHz
RO 4003	5mm	5mm	321 ohm	15.9 GHz
RO 3006	3mm	3mm	551 ohm	20.2 GHz
RO 3006	4mm	4mm	549 ohm	15.1 GHz
RO 3006	5mm	5mm	548 ohm	12.1 GHz

Table 2: Substrate comparison

3.6 Flow-chart For design Fabrication:

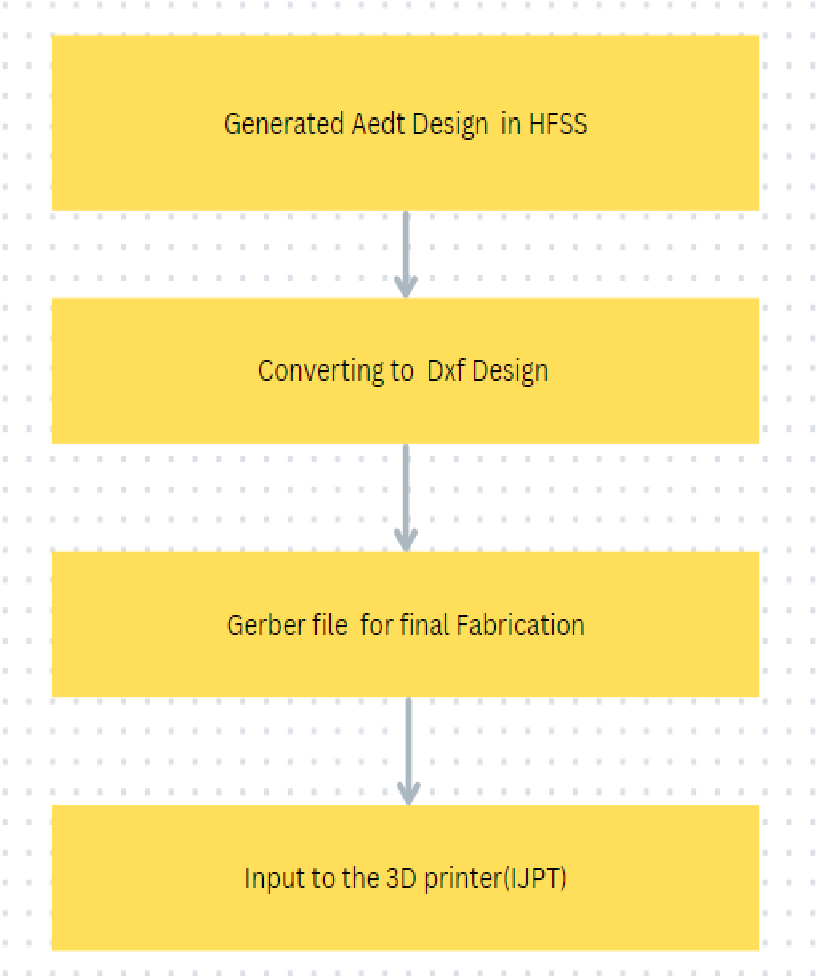

Fig 7 : Simulation to Fabrication

Converting an antenna design from an AEDT file to a format suitable for fabrication on a 3D printer, such as Gerber files, involves several steps. Here's a detailed guide:

1. Export AEDT File:

Save the antenna design in AEDT format.

2. Convert AEDT to DXF:

Use ANSYS AEDT or another software tool to convert the AEDT file to DXF format, which is commonly used for 2D CAD drawings.

3. Prepare DXF File:

Clean up the DXF file to remove any unnecessary layers or elements that are not part of the antenna geometry.

4. Convert DXF to Gerber:

Use a software tool or online converter to convert the DXF file to Gerber format, which is used for PCB fabrication but can also be adapted for 3D printing.

5. Prepare Gerber Files:

Review the Gerber files to ensure that they accurately represent the antenna geometry and include all necessary layers (e.g., copper traces, solder mask, silkscreen).

6. Export Gerber Files:

Save the Gerber files in a format compatible with the 3D printer, such as RS-274X.

7. Fabricate on 3D Printer:

Load the Gerber files into the 3D printer software and follow the manufacturer's instructions to set up the printing process.Select the appropriate printing materials (e.g., conductive filament for antennas) and printing parameters (e.g., layer height, printing speed).

3.7 Antenna Fabrication Process:

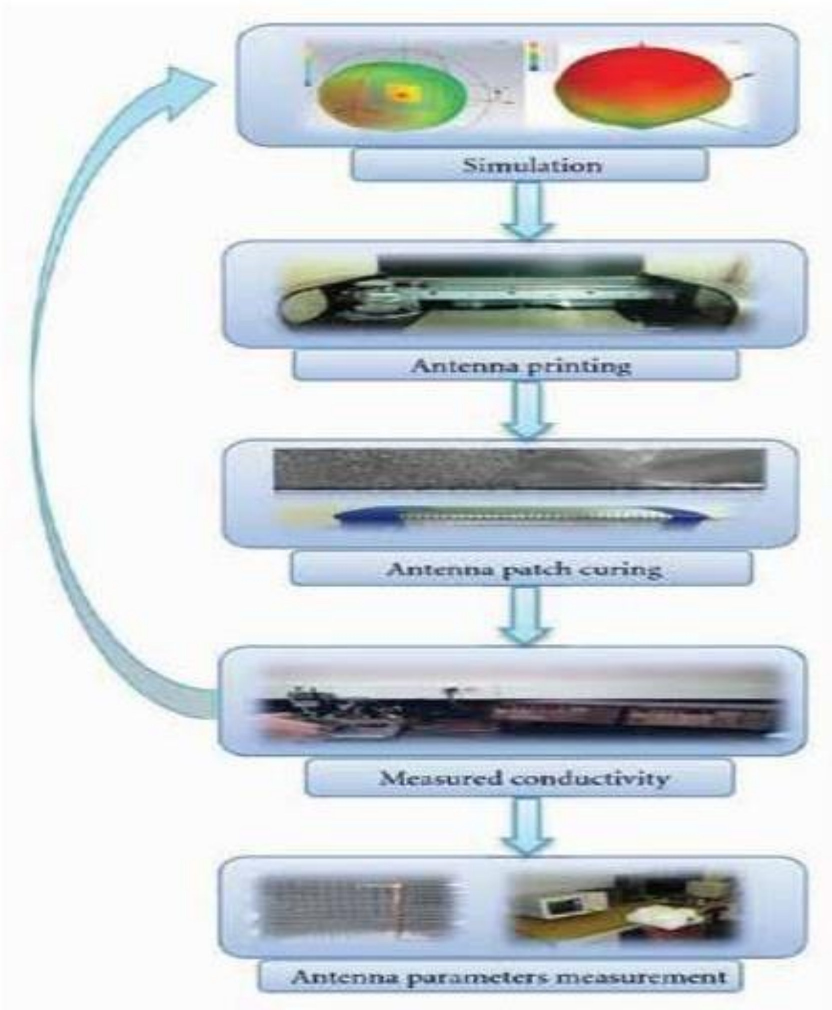

Fig 8: Antenna Fabrication

Here is a overview of the process from simulation to printing to patch curing to measuring conductivity for a microstrip inset feed antenna.

1. Simulation: The process begins with designing the microstrip inset feed antenna using simulation software such as ANSYS HFSS. The simulation helps optimize the antenna's performance by analyzing parameters like VSWR, gain, and radiation pattern.
2. Printing: Once the design is finalized, the antenna pattern is printed onto a substrate material using a printing method like inkjet printing or screen printing. Conductive ink or paste is used to create the antenna's conductive elements, such as the patch and feed line.
3. Curing: The printed substrate is then cured to fix the conductive elements in place and ensure adhesion to the substrate. Curing can be done using heat or UV light, depending on the type of ink or paste used.
4. Substrate Preparation: Before measuring conductivity, the substrate is prepared by cleaning it to remove any contaminants that could affect the measurements.
5. Measuring Conductivity: The conductivity of the antenna's conductive elements is measured using techniques such as four-point probe or conductivity meters. This measurement helps ensure that the antenna meets the desired electrical performance specifications.
6. Final Testing: Once the conductivity is measured and confirmed, the antenna undergoes final testing to validate its performance. This may include testing parameters such as VSWR, gain, and radiation pattern to ensure that they align with the simulation results.
7. Integration: After testing, the antenna can be integrated into the final product or system for use in 5G applications.

3.8 Hardware used:

Fig. 10: Rogers logo

RO3006 material: It provide a stable dielectric constant (Dk) over a range of temperatures. This stability eliminates the step change in Dk that occurs for PTFE glass materials near room temperature.

Features:

- Dk of 6.15 +/- .15
- Dissipation factor of .0020 at 10GHz
- Low X, Y and Z axis CTE of 17, 17 and 24 ppm/°C, respectively Benefits
- ISO 9001 Certified
- Uniform mechanical properties with other RO3000™ Series laminates allows for multi-layer board designs
- Cost effective option

3.9 Software used:

Fig. 9: Ansys logo

ANSYS HFSS 2023: ANSYS HFSS (High-Frequency Structure Simulator) is a powerful electromagnetic simulation software tool used for designing and simulating high-frequency electronic components such as antennas, RF/microwave components, integrated circuits, and more. It utilizes the Finite Element Method (FEM) and Method of Moments (MoM) to solve complex electromagnetic field problems

Key features of ANSYS HFSS include:

- Full-wave 3D electromagnetic field simulation capabilities.
- Integration with other ANSYS tools for Multiphysics simulations, such as thermal and structural analysis.
- Automated meshing and adaptive mesh refinement for accurate and efficient simulations.
- Optimization tools for improving the performance of designs based on user- defined objectives.
- Support for various boundary conditions, material properties, and excitation sources.
- Visualization tools for analyzing simulation results, including 3D field plots, charts, and graphs.

3.10 Working principle of the proposed system:

The proposed system operates on the foundational principles of a microstrip inset feed antenna, which builds upon the concept of a microstrip patch antenna. This type of antenna features a metallic patch situated atop a dielectric substrate, forming a compact and efficient radiating element. The key innovation lies in its inset feed configuration, wherein the feed line is strategically connected to the patch along one of its edges, deviating from conventional corner-fed designs. This feeding technique optimizes signal transmission and reception, fostering enhanced performance characteristics such as gain, directivity, and signal quality. By precisely controlling the feed point location and dimensions, the antenna achieves impedance matching and radiation efficiency, crucial for its efficacy in diverse wireless communication applications. This configuration offers advantages in terms of compactness, ease of integration, and versatility, making it well-suited for deployment in modern communication systems requiring robust and reliable performance.

1.RF Signal Generation: The RF signal generation process initiates within the transmitter circuitry of the communication device. Here, electrical signals from a modulation source are transformed into radio frequency (RF) signals, which serve as carriers for transmitting information wirelessly. This process typically involves modulating a carrier wave with the baseband signal to encode data, followed by amplification to achieve the desired power level for transmission. The generated RF signal carries the encoded information and is then transmitted through the antenna to propagate wirelessly to the intended receiver. This initial step in the communication process is fundamental, laying the groundwork for subsequent transmission and reception stages within the system.

2.Signal Feed: After generation, the RF signal is directed into the inset feed line of the microstrip antenna. This feed line serves as the conduit through which the RF signal is delivered to the antenna's radiating element, typically a metallic patch situated on a dielectric substrate. Unlike traditional corner-fed configurations, the inset feed line connects to the patch along one of its edges, optimizing signal transmission efficiency. This precise feeding mechanism ensures proper impedance matching between the feed line and the antenna, maximizing the transfer of RF energy for radiation. By channeling the RF signal into the inset feed line, the antenna becomes primed to emit electromagnetic waves, carrying encoded information for wireless transmission.

3.Electromagnetic Field Creation: Upon reaching the antenna's patch, the RF signal undergoes a transformation, generating an electromagnetic field across the patch's surface. This process is fundamental to the antenna's operation, as it converts electrical energy from the RF signal into electromagnetic radiation. The interaction between the RF signal and the metallic patch, situated atop the dielectric substrate, results in the establishment of an electromagnetic field characterized by oscillating electric and magnetic components.These fields propagate outward from the antenna, forming electromagnetic waves that propagate through space, carrying the encoded information embedded in the

RF signal. This step marks the transition from electrical signals within the antenna to the emission of electromagnetic waves for wireless transmission.

4.Current Flow: As the electromagnetic field permeates the patch of the antenna, it induces a flow of electrical current within the metallic structure. This current flowis a consequence of the interaction between the oscillating electric field component of the electromagnetic waves and the conductive properties of the patch material. The alternating nature of the electromagnetic field prompts electrons within the metallic patch to move back and forth, generating time-varying currents. These currents, in turn, contribute to the emission of electromagnetic waves from the antenna. By harnessing the principles of electromagnetism, this process facilitates the conversion of electrical energy carried by the RF signal into electromagnetic waves, ready for propagation into the surrounding space for wireless communication.

5.Wave Propagation: Following the generation of electromagnetic waves within the antenna structure, these waves propagate outward into the surrounding space. This propagation process entails the transmission of electromagnetic energy through the air or other medium, allowing the encoded information carried by the waves to be disseminated over a considerable distance. As the waves radiate away from the antenna, they travel in all directions, forming an expanding spherical wavefront. The electromagnetic waves propagate at the speed of light, dictated by the properties of the transmission medium, such as air or a dielectric material. This step in the communication process marks the dissemination of information- bearing electromagnetic energy, enabling wireless communication between the transmitting antenna and receiving devices within the coverage area.

6.Radiation Pattern: The radiation pattern of the antenna, crucial for understanding its directional characteristics, is influenced by various factors inherent in its design. Chief among these are the size and shape of the patch, along with the properties of the substrate material. The dimensions of the patch dictate the distribution of electromagnetic energy in space, influencing the antenna's coverage area and directional properties. Additionally, the dielectric properties of the substrate impact the propagation of electromagnetic waves, further shaping the radiation pattern. By carefully configuring these design parameters, antenna engineers can tailor the radiation pattern to meet specific application requirements, ensuring optimal coverage and signal propagation in desired directions.

7.Antenna Gain: The gain of the antenna plays a pivotal role in determining the strength of the radiated signal in the desired direction. This parameter quantifies the antenna's ability to focus electromagnetic energy into a specific directioncompared to an isotropic radiator, which radiates energy equally in all directions. A higher gain implies a more concentrated radiation pattern, resulting in increased signal strength in the intended direction of communication. Antennas with higher gains are particularly advantageous in scenarios where long-distance communication or improved signal reception is essential, as they enhance signal transmission efficiency and reception sensitivity.

By optimizing the antenna's design and configuration to achieve higher gain, engineers can effectively enhance the performance and reliability of wireless communication system.The inset feed configuration helps in achieving impedance matching between the feed line and the patch, which is crucial for efficient signal transmission and reception. It also allows for easier tuning of the antenna for specific operating frequencies.

Chapter-4

Results and Discussions

4.1 Simulation Results:

The results or the outcome of the project work could be summarized as follows:

Radiated E Field:

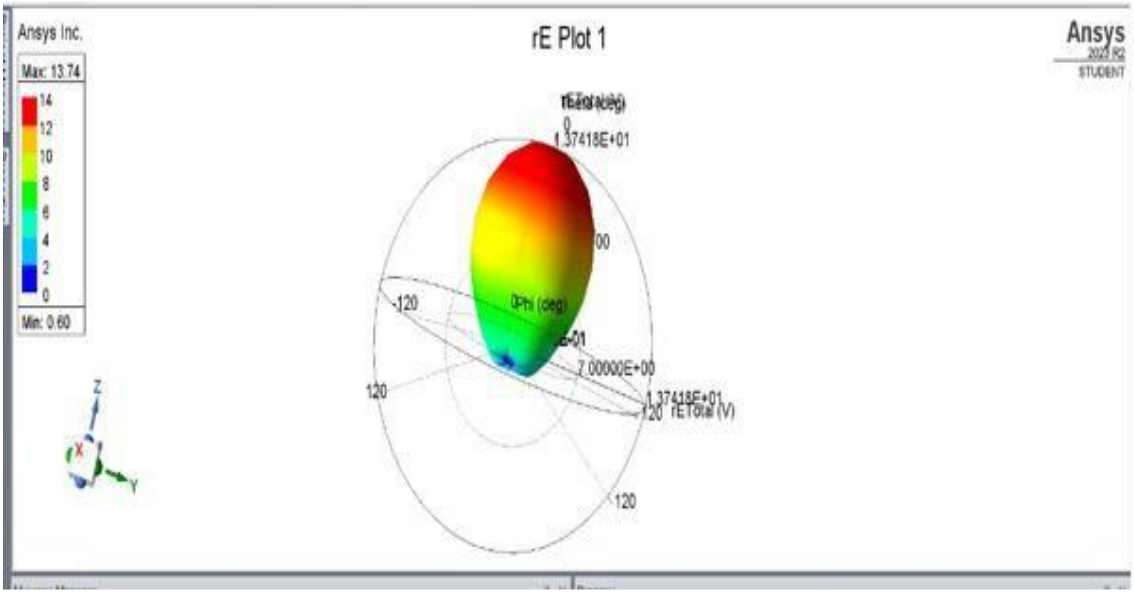

Fig. 11 : Radiation Pattern

The "Radiated E Field" illustrates the distribution of the electric field (E field) in the vicinity of the Inset Feed Microstrip Antenna during operation. This visual representation is crucial for understanding how electromagnetic waves are radiated from the antenna structure.In ANSYS HFSS, generating a radiated electric field plot of an antenna involves several steps. Here's a general outline of the process:

Geometry Creation: Create the geometry of your antenna structure in HFSS. This involves defining the antenna's physical dimensions, materials, and any other relevant geometric features.

Meshing: Generate a mesh for the antenna geometry. The mesh should be fine enough to accurately capture the electromagnetic behavior of the antenna.

Excitation Setup: Define the excitation source for the antenna. This typically involves specifying the frequency, type of excitation (e.g., voltage or current source), and any other relevant parameters.

Solver Setup: Configure the HFSS solver settings, including the frequency range, simulation type (e.g., eigenmode, driven modal), and convergence criteria.

Simulation: Run the simulation to solve for the electromagnetic fields around the antenna. Ensure that the simulation converges and produces reliable results.

Results Visualization: Once the simulation is complete, you can visualize the results, including the radiated electric field. In HFSS, you can typically generate plots of various field quantities, such as electric field magnitude, electric field vector, and radiation pattern.

Post-Processing: Analyze the results to gain insights into the antenna's performance. You can extract key parameters such as gain, directivity, and efficiency from the radiation pattern plot.To specifically generate a plot of the radiated electric field, you would typically follow these steps:

Gain Plot:

Fig12 : Gain Plot

The "Gain Plot" depicts the variation of antenna gain across different frequencies or angles. Gain represents the ability of the antenna to concentrate radiated power in a specific direction compared to an isotropic radiator. For an antenna with a VSWR gain that is maximum at 29.8 GHz and has a bandwidth of 4 GHz.To plot the gain of an antenna in ANSYS HFSS, you can follow these general steps:

Geometry Setup: Create the geometry of your antenna in HFSS, ensuring that it accurately represents your design.

Excitation Setup: Specify the excitation source for the antenna. This could be a voltage or current source applied to the antenna structure. Make sure to set the excitation parameters appropriately for your antenna's operating frequency and characteristics.

Solver Setup: Configure the solver settings in HFSS. Set the frequency range and simulation type according to your requirements. Ensure that the solver settings are suitable for accurately capturing the antenna's radiation behavior.

Simulation: Run the simulation to solve for the electromagnetic fields around the antenna. Ensure that the simulation converges properly.

Results Visualization: Once the simulation is complete, you can visualize the results, including the gain of the antenna. Here's how you can do it:

a. In the HFSS project, go to the Results tab.

b. Under the Field Overlays or Results sections, locate the option for Gain.

c. Choose the appropriate settings for the gain plot.

You may need to specify the frequency or frequency range of interestd. Generate the plot to visualize the gain distribution of the antenna.

Post-Processing: Analyze the gain plot to understand the antenna's radiation characteristics. You can examine the peak gain, beamwidth, and other relevant parameters to evaluate the antenna's performance. By following these steps, you can generate a plot of the gain of your antenna in ANSYS HFSS.

Voltage standing wave ratio (VSWR):

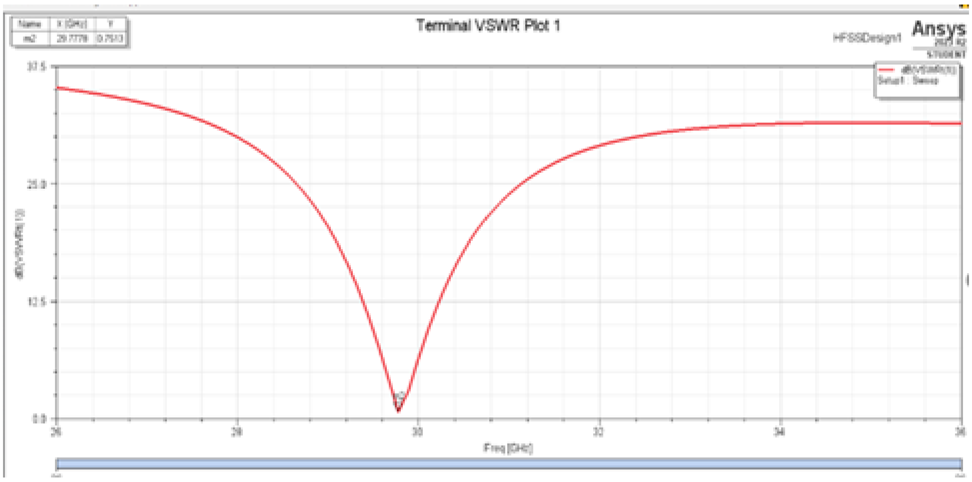

Fig 13 : VSWR Plot

Plotting Voltage Standing Wave Ratio (VSWR) in ANSYS HFSS involves a similar process to plotting S-parameters, as VSWR is related to reflection coefficients. Here's a general guide:

Simulation Setup: Set up your simulation in HFSS to calculate S-parameters. Ensure that the frequency range and other simulation settings are appropriate for your analysis.

S-Parameter Calculation: During simulation setup, specify the calculation of S-parameters. HFSS will compute the S-parameters based on your simulation configuration.

Simulation Run: Execute the simulation to compute the S-parameters for your device.

Results Viewing: Once the simulation is complete, navigate to the Results tab in HFSS.

VSWR Calculation: VSWR can be calculated from S-parameters using the following formula:

$$\mathbf{VSWR= 1-|\Gamma|/1+|\Gamma|}$$

Where Γ is the reflection coefficient, which can be calculated from the S11 parameter if you're dealing with a two-port device.

If you have S-parameters in dB (decibels), convert them back to linear scale before computing the VSWR.

Plotting VSWR: After calculating VSWR from the reflection coefficient, you can plot it against frequency using the following steps:a. Compute the reflection coefficient Γ from the S11 parameter.b. Calculate VSWR using the formula above.c. Create a plot of VSWR versus frequency using the appropriate tool in HFSS. This might involve plotting a graph with frequency on the x-axis and VSWR on the y-axis.

Post-Processing: Analyze the VSWR plot to understand the device's performance. Look for frequency ranges with high VSWR values, which indicate poor impedance matching or high reflection.

Additional Considerations: Ensure that your simulation setup and boundary conditions accurately represent the practical scenario in which your device operates. Adjustments may be necessary to improve the accuracy of the results.By following these steps, you can plot the Voltage Standing Wave Ratio (VSWR) of your device in ANSYS HFSS and analyze its performance in terms of impedance matching and reflection characteristics across different frequencies.

Scattering Parameter Plot:

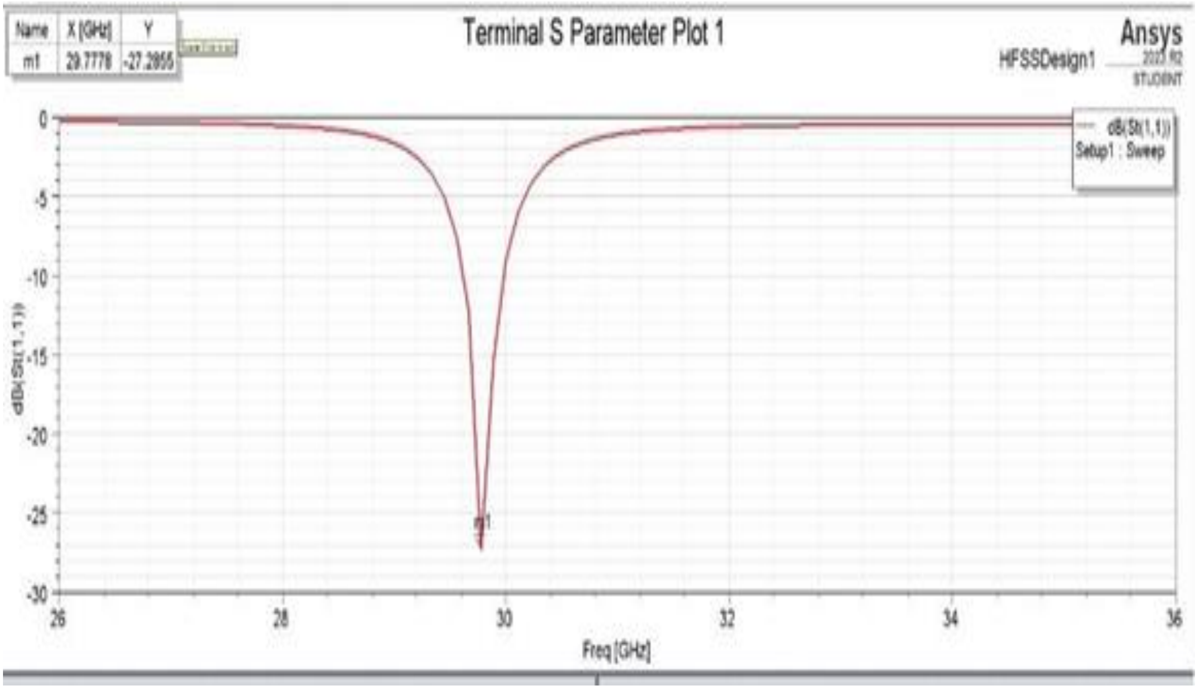

Fig. 14 : S Parameter Plot

For the Inset Feed Microstrip Antenna, the S-parameter plot would illustrate how well the antenna impedance matches with the connected transmission line, ensuring efficient signal transfer. The plot can identify resonant frequencies, bandwidth, and potential impedance mismatches that might affect the antenna's performance. To plot S-parameter (scattering parameter) data in ANSYS HFSS, typically you'd follow these steps:

Simulation Setup: Set up your simulation in HFSS to calculate S-parameters. This involves defining your geometry, excitation, and simulation settings.

S-Parameter Calculation: Ensure that during the simulation setup, you have chosen to calculate S-parameters. HFSS will compute the S-parameters based on your simulation setup, which typically involves defining ports for excitation and observation.

Simulation Run: Execute the simulation to compute the S-parameters for your device.

Results Viewing: Once the simulation is complete, you can view the S-parameter data. Here's how:

a. Go to the Results tab in HFSS.

b. Look for the S-Parameter Results section.

c. You will typically see a matrix of S-parameter data, often represented as S11, S12, S21, S22, etc., depending on the number of ports and the type of simulation.

Plotting S-Parameters: From the S-Parameter Results section, you can plot the S-parameter data. Here's how you might do it:a. Select the specific S-parameter you want to plot (e.g., S11, S21).b. Right-click on the selected parameter and choose "Insert Plot." This will create a plot window with the selected S-parameter data.c. You can customize the plot settings, such as frequency range, scale, and appearance, to suit your analysis needs.d. You may repeat this process for other S-parameters if desired.

Post-Processing: Analyze the plotted S-parameter data to understand the device's behavior. You can examine characteristics such as insertion loss, return loss, bandwidth, and impedance matching from the S-parameter plots.By following these steps, you can plot S-parameter data in ANSYS HFSS and analyze the performance of your device in terms of its frequency-dependent behavior and interactions with other components or systems.

RADIATION VISUALIZATION:

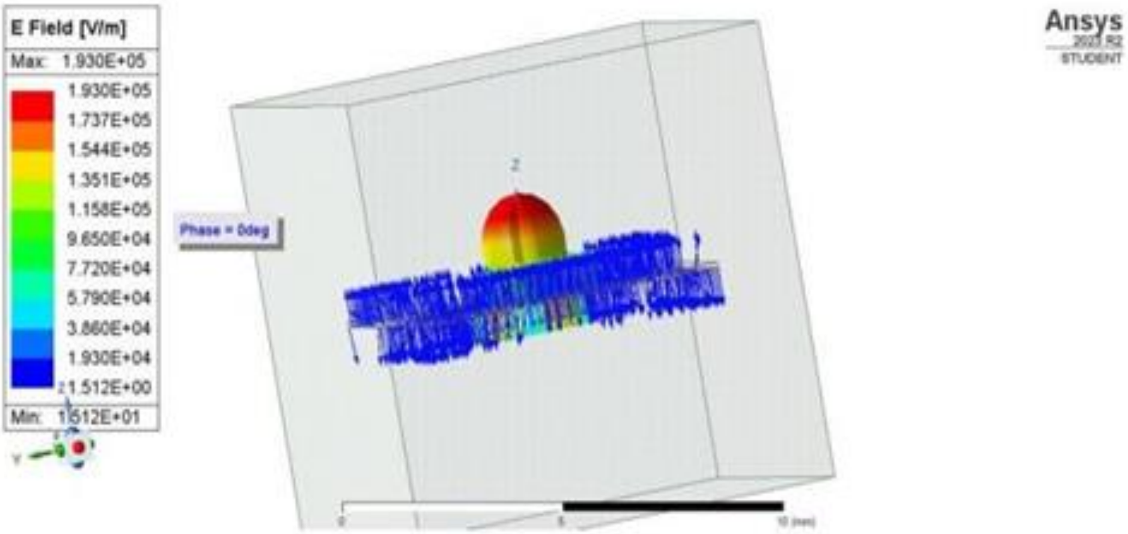

Fig. 15 : Radiation Visualization

The "Radiation Visualization" in the project report likely refers to a graphical representation or simulation illustrating the three-dimensional radiation pattern of the Inset Feed Microstrip Antenna. This visualization provides a comprehensive view of how the antenna radiates electromagnetic waves into space.To visualize radiation in High-Frequency Structure Simulator (HFSS), follow these steps:

1. Create Radiation Setup:

- Open your HFSS project.
- Set up your antenna or device for radiation analysis using appropriate boundaries and excitations.

2. Define Radiation Properties:

- In the HFSS project manager, right-click on "Radiation" under your project's solution setup.
- Select "Insert Radiating Setup" to define the radiation properties.
- Specify the frequency range and radiation type (far-field, near-field, etc.).

3. Run Analysis:

- Run the simulation to compute the radiation characteristics of your structure.

4. View Radiation Results:

- After the simulation completes, navigate to the "Results" tab in HFSS.
- Expand the "Radiation" section to access various radiation-related results.
- Common results include radiation patterns, gain, directivity, and far-field plots.

5. Visualize Radiation Patterns:

- To view radiation patterns, select the desired result (e.g., 2D or 3D radiation pattern) from the available options.
- Customize the display settings as needed to visualize the radiation pattern effectively.

6. Analyze Other Radiation Characteristics:

- Explore additional radiation characteristics such as gain, directivity, and total radiated power from the results menu.

By following these steps, you can effectively visualize radiation in HFSS and analyze various radiation-related properties of your antenna or electromagnetic structure.\

4.2 Fabrication Results:

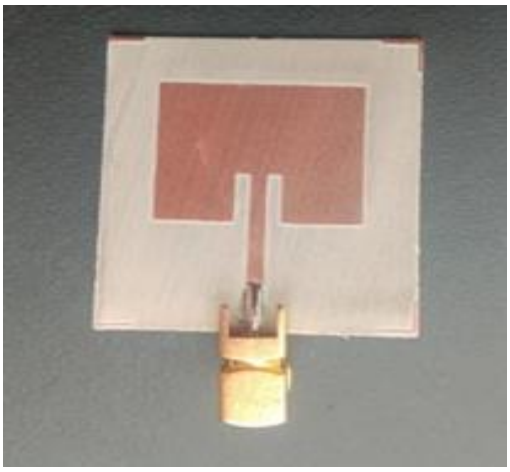

Fig. 16: Front View of Antenna

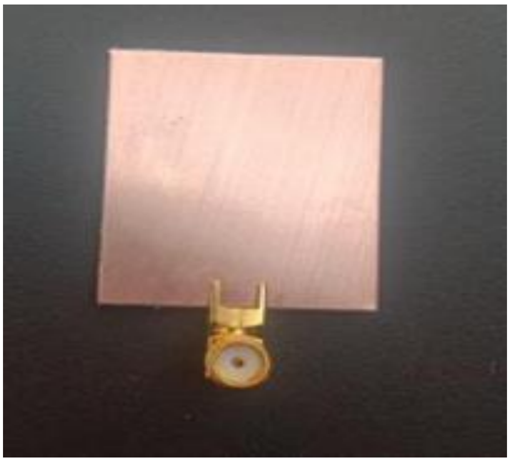

Fig. 17: Bottom View of Antenna

To visualize radiation in High-Frequency Structure Simulator (HFSS), follow these steps:

1. Create Radiation Setup:

- Open your HFSS project.
- Set up your antenna or device for radiation analysis using appropriate boundaries and excitations.

2. Define Radiation Properties:

- In the HFSS project manager, right-click on "Radiation" under your project's solution setup.
- Select "Insert Radiating Setup" to define the radiation properties.
- Specify the frequency range and radiation type (far-field, near-field, etc.).

3. Run Analysis:

- Run the simulation to compute the radiation characteristics of your structure.

4. View Radiation Results:

- After the simulation completes, navigate to the "Results" tab in HFSS.
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6. Analyze Other Radiation Characteristics:

- Explore additional radiation characteristics such as gain, directivity, and total radiated power from the results menu.By following these steps, you can effectively visualize radiation in HFSS and analyze various radiation-related properties of your antenna or electromagnetic structure.

4.3 Applications:

1. **Internet of Things (IoT):** Microstrip antennas are well-suited for IoT devices due to their compact size, lightweight, and ease of integration. They play a crucial role in providing connectivity for IoT sensors and devices.
2. **Automotive Communications:** In modern vehicles, microstrip antennas are employed for communication systems such as GPS, satellite radio, and in-car wireless networks. Their low profile and adaptability make them ideal for integration into automotive designs.
3. **Smart Grids:** Microstrip antennas are used in smart grid systems for monitoring and communication purposes. They facilitate wireless communication between smart meters, sensors, and control centers, enhancing the efficiency of electrical grids.
4. **Remote Sensing:** In satellite and remote sensing applications, microstrip antennas are utilized for communication links between satellites, ground stations, and other remote sensing devices. Their lightweight and directional capabilities make them suitable for space applications.
5. **Radar Systems:** Microstrip antennas find application in radar systems for their ability to operate at microwave frequencies. They are employed in military, weather, and air traffic control radar systems for detecting and tracking objects.
6. **Wi-Fi and Wireless Local Area Networks (WLAN):** Microstrip antennas are commonly used in Wi-Fi routers and WLAN systems. Their compact size and ease of integration make them suitable for providing wireless connectivity in homes, offices, and public spaces.
7. **Unmanned Aerial Vehicles (UAVs):** Microstrip antennas are used in UAVs for communication, telemetry, and remote sensing applications. Their lightweight nature and ability to operate at high frequencies contribute to the efficiency of communication systems on UAVs.
8. **Military and Defense Applications:** Microstrip antennas play a vital role in military communication systems, electronic warfare, and radar applications. Their compact design and directional capabilities contribute to their use in various defense technologies.
9. **Industrial Automation:** In industrial automation, microstrip antennas are employed for wireless communication between sensors, controllers, and monitoring systems. They facilitate data exchange in industrial environments, contributing to automation processes.
10. **Environmental Monitoring:** Microstrip antennas can be used in environmental monitoring systems for collecting and transmitting data from sensors deployed in remote or challenging terrains. They contribute to applications such as weather monitoring and environmental research.

4.4 Advantage:

1. **Low Profile:** Microstrip antennas have a flat and low-profile design, making them suitable for applications where a compact and unobtrusive form factor is essential. This characteristic is particularly beneficial in situations where space constraints are a consideration.
2. **Lightweight:** The construction of microstrip antennas involves lightweight materials, such as dielectric substrates and thin conducting patches. This lightweight nature is advantageous in applications where minimizing weight is critical, such as in aerospace and automotive industries. .
3. **Cost-Effective:** The manufacturing process of microstrip antennas is generally less complex compared to some other antenna types. This simplicity contributes to their cost effectiveness, making them economically viable for various applications.
4. **Ease of Integration:** Microstrip antennas can be easily integrated into the surface of a host system, whether it's a communication device, a vehicle, or a sensor. This ease of integration allows for flexibility in incorporating antennas into diverse systems and designs.
5. **Wide Frequency Range:** Microstrip antennas can be designed to operate over a wide range of frequencies, from relatively low frequencies to microwave and millimeter-wavefrequencies. This versatility makes them suitable for various wireless communication systems.
6. **Directional and Omnidirectional:** Options Microstrip antennas can be designed to exhibit either directional or omnidirectional radiation patterns. This flexibility allows engineers to choose the antenna type that best suits the specific requirements of a given application
7. **Suitable for Planar Structures:** Microstrip antennas are inherently planar, making them compatible with planar structures such as printed circuit boards. This characteristic simplifies their integration into electronic systems and devices.
8. **Good Radiation Efficiency:** When properly designed, microstrip antennas can achieve high radiation efficiency, ensuring that a significant portion of the input power is radiated as electromagnetic waves. This efficiency is crucial for effective communication.
9. **Compact Size:** Inset feed allows for a more compact antenna design compared to other feeding techniques, making it suitable for applications where space is limited.
10. **Broadband Operation:** It can achieve broadband operation, especially when combined with other techniques like impedance matching or using specific substrate materials

4.5 Limitations

1. **Bandwidth:** While the bandwidth of a microstrip inset feed antenna can be sufficient for many 5G applications, it may not be as wide as some other antenna types, such as horn antennas or slot antennas. This limitation could impact the antenna's ability to support the full range of frequencies used in 5G.
2. **Power Handling Capacity:** Microstrip antennas, including inset feed designs, may have limitations in terms of the power they can handle. In high-power applications, such as certain 5G base station scenarios, this limit could be a concern
3. **Manufacturing Complexity**: Fabricating microstrip antennas with high precision and consistency can be challenging, especially for designs that require tight tolerances or specialized materials.
4. **Cross-Polarization:** Microstrip antennas, including inset feed designs, may exhibit significant cross-polarization, which could lead to signal degradation in certain scenarios.
5. **Environmental Sensitivity:** Microstrip antennas, particularly those with exposed components, may be more susceptible to environmental factors such as moisture, dust,and temperature fluctuations, which could affect their performance over time.
6. **Size and Design Complexity:** Achieving optimal performance often requires careful tuning of dimensions and feed positions, which can increase design complexity and size.Sensitivity to
7. **Nearby Objects:** Inset feed microstrip antennas can be sensitive to nearby objects, structures, or changes in their environment, which may affect their performance.

Chapter-5

Conclusions, Future Work & Scope of Project

5.1 Conclusions:

In embarking on the "Design and Implementation of Inset Feed Microstrip Antenna for 5G Applications," this study endeavors to contribute to the evolving landscape of antenna technology. Through a comprehensive exploration of microstrip antennas, the research aims to address the unique challenges posed by the demands of 5G communication systems. As we anticipate the journey ahead, several key conclusions guide the trajectory of this work.

Innovative Approach: The proposed methodology integrates advanced electromagnetic simulation tools, notably HFSS on Ansys, with mathematical modeling and practical implementation. This synergy aims to create a holistic approach, leveraging simulation insights and mathematical precision for the meticulous design and realization of the microstrip antenna.

Main Achievements: The study anticipates achieving a microstrip antenna design optimized for 5G applications. The key achievements include the exploration of innovative inset feed Design and Implementation of Inset Feed Microstrip Antenna Design for 5G Applications configurations, the meticulous tuning of antenna parameters for resonance at 5G frequencies, and the integration of lightweight, low-profile designs suitable for diverse applications.

Standout Features: The standout features of this project lie in the emphasis on adaptability and versatility. The microstrip antenna design strives to be adaptable to various applications, including aircraft, satellites, mobile and radio communication, wireless communications, RFID, healthcare, and more. The low profile and lightweight nature of the antenna aim to offer a solution that seamlessly integrates into different systems and environments.

Evaluation of Study: In evaluating the study, it is evident that the integration of HFSS, MATLAB, and practical implementation creates a robust feedback loop. This iterative process allows for continuous refinement, ensuring that the design aligns with the stringent requirements of 5G communication systems. Strengths and Weak Points: Strengths lie in the careful consideration of space and weight constraints, adherence to industry standards, and the application of innovative design principles. Weak points, if any, may emerge during the practical implementation phase, necessitating vigilant attention to real-world challenges.

5.2 Future Work & Scope of Project:

The domain of microstrip inset feed antennas for 5G applications holds immense potential for future advancements. Some key areas of future scope include:

1. **Miniaturization:** Continued research into miniaturization techniques could lead to even smaller and more compact antennas, suitable for integration into wearable devices, IoT sensors, and other small form-factor devices.
2. **Bandwidth Enhancement:** Improvements in bandwidth enhancement techniques could result in antennas capable of supporting even wider frequency ranges, enabling future 5G networks to deliver even higher data rates and lower latency.
3. **Beamforming and MIMO:** Further advancements in beamforming and MIMO (Multiple Input Multiple Output) technologies could enhance the performance of microstrip inset feed antennas, enabling them to support higher data rates and more reliable communication in dense urban environments.
4. **Integration with Other Technologies:** Integration of microstrip inset feed antennas with other technologies, such as AI (Artificial Intelligence) and IoT, could lead to innovative applications in smart cities, autonomous vehicles, and healthcare.
5. **Environmental Robustness:** Research into materials and design techniques that improve the environmental robustness of microstrip antennas could lead to antennas that are more resistant to factors such as moisture, dust, and temperature fluctuations.
6. **Manufacturing Advances:** Advances in manufacturing technologies, such as 3D printing and advanced materials, could streamline the production process and reduce costs, making microstrip inset feed antennas more accessible for a wider range of applications.
7. **Millimeter-wave Applications:** With the rise of millimeter-wave communication for high-speed data transfer and short-range applications, there is a growing demand for antennas operating at these frequencies. Inset feed microstrip antennas can be designed to operate efficiently at millimeter-wave frequencies, making them valuable for future applications in wireless networks and point-to-point communication.
8. **Satellite Communication:** Inset feed microstrip antennas can also find applications in satellite communication systems. Their lightweight and compact nature make them ideal for satellite payloads, providing high-performance communication links for various satellite-based services such as broadband internet, remote sensing, and satellite broadcasting.Advanced Materials and Fabrication Techniques: Advances in materials science and fabrication techniques will further enhance the performance and capabilities of inset feed microstrip antennas. Integration with metamaterials, graphene, and other novel materials could lead to antennas with improved efficiency, wider bandwidth, and better radiation characteristics.

5.3 Outcome of the project works:

The outcome of a project focused on the design and implementation of a microstrip inset feed 5G antenna would typically include several key elements:

1. **Antenna Design:** The project would result in a detailed design of the microstrip inset feed antenna, including specifications such as dimensions, substrate material, feed position, and impedance matching network design. The design would be optimized for 5G frequency bands and performance requirements.
2. **Simulation Results:** Using software tools like ANSYS HFSS, the project would simulate the antenna design to evaluate its performance characteristics such as VSWR, gain, radiation pattern, and bandwidth. The simulation results would validate the antenna's design and provide insights for further optimization.
3. **Prototype Fabrication:** Based on the optimized design, a prototype of the microstrip inset feed antenna would be fabricated. The fabrication process would involve techniques such as PCB etching or 3D printing, depending on the antenna's complexity and requirements.
4. **Experimental Testing:** The fabricated prototype would undergo experimental testing to validate its performance in real-world conditions. Testing would include measuring parameters such as VSWR, gain, radiation pattern, and impedance matching.
5. **Performance Evaluation:** The project would evaluate the performance of the microstrip inset feed antenna against the initial design goals and requirements for 5G applications. This would include assessing factors such as signal strength, coverage, and reliability.
6. **Documentation and Reporting:** Finally, the project would document the design, simulation, fabrication, and testing processes, along with the results and conclusions. A comprehensive report would summarize the project's findings, including any recommendations for future work or improvements.

Overall, the outcome of the project would be a validated design and prototype of a microstrip inset feed 5G antenna, demonstrating its feasibility and performance for future wireless communication applications.

References

[1] John Colaco, Rajesh Lohani, “Design and Implementation of Microstrip Patch Antenna for 5G Applications,” in Proceedings of the International Conference on Communication and Electronics (ICCES 2020), 2020.

[2] N. A. Wahab and W. N. S. W. Muhamad, “Microstrip Array Antenna with Inset-fed forWLAN Application,” Indonesian Journal of Electrical Engineering and Computer Science, vol. 17, no. 1, pp. 176-183, January 2020.

[3] H. Chaurasiya and S. Shankar, "Inset Feed Microstrip Patch Antenna," in Proceedings of the IEEE International Conference on Computer, Communication and Control (IC4-2015), A.S.E.T., Amity University.

[4] A. K. M. Baki, Md. Nurur Rahman, and Shawon Kumar Mondal, "Analysis of Performance- Improvement of Microstrip Antenna at 2.45 GHz Through Inset Feed Method," in Proceedings of the 1st International Conference on Advances in Science, Engineering and Robotics Technology 2019 (ICASERT 2019), Department of Electrical Engineering

[5] N. Sathishkumar, S. Arthika, G. Indhu, Elakkiya, "Design and Study of Rectangular Microstrip Patch Antenna for WLAN Applications," International Journal of Advanced Science and Technology, Department of ECE, KPR Institute of Engineering and Technology, Coimbatore.

[6] Jaget Singh, "Inset Feed Microstrip Patch Antenna," International Journal of Computer Science and Mobile Computing, Vol. 5, Issue. 2, February-2016, pp. 324-329, UIET, Panjab University Chandigarh.

[7] P. A. Nawale, Prof. R.G. Zope, "Design and Improvement of Microstrip Patch Antenna Parameters Using Defected Ground Structure," P. A. Nawale et al Int. Journal of Engineering Research and Applications, Vol. 4, Issue 6 (Version 3), June 2014, pp. 123-129.

[8] Sant Sharan Shukla, Rahul Kumar Verma, Gurpreet Singh Gohir, "Investigation of the effect of Substrate material on the performance of Microstrip antenna," Department of Electronics and Communication Engineering, Amity University Uttar Pradesh.

[9] Shera Prabjyot Singh, Ashish Singh, Deepak Upadhyay, Sunilkumar Pal, Mahesh Munde, "Design and Fabrication of Microstrip Patch Antenna at 2.4 GHz for WLAN Application using HFSS," IOSR Journal of Electronics and Communication Engineering (IOSR-JECE), e-ISSN: 2278- 2834, p-ISSN: 2278-8735.

[10] C. A. Balanis, "Antenna Theory: Analysis and Design," 2nd Edition; John Wiley Sons Inc. New York, 2001, pp. 12-130.

[11] H. M. Shoaib, K. M. Mehedi Hassan, M. Karim, and A. K. M. Ehtesanul Islam, "Study on the Effect of Double Inset Fed for Microstrip Patch Antenna for 5G Application," in 2023 International Conference on Computational Intelligence, Communication Technology and Networking (CICTN), Apr. 2023, pp. 283-287.Y. Li, "A microstrip patch antenna for 5G mobile communications," J. Phys.: Conf. Ser., vol. 2580, no. 1, p. 012063, Sep. 2023.

Appendix

Software descriptions:

ANSYS 2023 Student Version

Key features of ANSYS Electronic Desktop include:

Circuit Simulation: Users can simulate and analyze analog, digital, and mixed- signal circuits. The software offers various circuit simulation techniques, including transient, AC, and DC analysis.

Electromagnetic Simulation: ANSYS Electronic Desktop allows users to simulate electromagnetic fields and interactions. It includes tools for analyzing antennas, RF/microwave components, and high-speed digital interconnects.

Signal Integrity Analysis: The software provides tools for analyzing signal integrity issues in high-speed digital designs. Users can simulate effects such as reflections, crosstalk, and impedance mismatch.

3D Modeling: ANSYS Electronic Desktop includes 3D modeling capabilities for designing complex electronic components and systems. Users can create geometric models and analyze them for electromagnetic compatibility (EMC) and thermal performance.

Post-Processing: After running simulations, users can visualize and analyze the results using built-in post-processing tools. This includes generating plots, graphs, and reports to evaluate the performance of their designs.

Integration: ANSYS Electronic Desktop integrates with other ANSYS products, allowing users to combine electromagnetic, thermal, and structural analyses in a single platform. This enables comprehensive multiphysics simulations for complex electronic systems.

Hardware descriptions:

Rogers RO3006 is a high-frequency laminate material designed for use in RF and microwave applications. It is known for its excellent electrical performance and reliability, making it suitable for demanding high-frequency circuits. Here is a description of the key features and characteristics of Rogers RO3006:

1. **Dielectric Constant (εr):** RO3006 has a low dielectric constant of around 6.15 ± 0.15, which is stable over a wide frequency range. This low dielectric constant helps in achieving high-performance RF and microwave circuits.
2. **Loss Tangent (Dissipation Factor):** The loss tangent of RO3006 is typically around 0.0029, which indicates low signal loss and high signal integrity. This is crucial for maintaining high-quality signals in high-frequency applications.
3. **Thickness:** RO3006 is available in various thicknesses, ranging from 0.0028 inches (0.071 mm) to 0.062 inches (1.57 mm), allowing for flexibility in design and application.
4. **Temperature Stability:** RO3006 exhibits good thermal stability, with a low coefficient of thermal expansion (CTE). This ensures that the material maintains its electrical properties over a wide temperature range.
5. **Copper Clad Laminates:** RO3006 is available as a copper-clad laminate, with different copper thickness options to suit various application requirements.
6. **Applications:** Due to its excellent electrical properties, RO3006 is commonly used in high-frequency applications such as RF and microwave circuits, antennas, power amplifiers, and radar systems.
7. **Fabrication:** RO3006 can be easily fabricated using standard PCB manufacturing processes, including etching, drilling, and plating, making it suitable for high- volume productio

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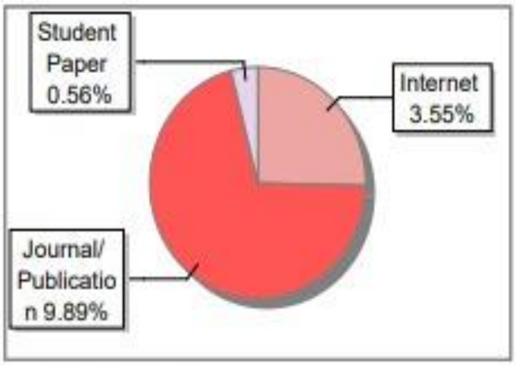

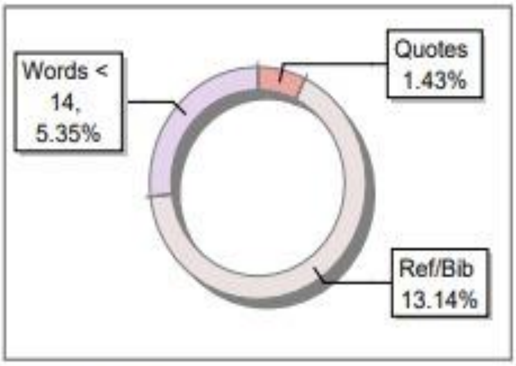

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CO-PO Mapping Justification Sheets

CO-PO Mapping:

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	2	3	1	2	2	3	2	2	3	3
CO2	2	2	3	2	2	3	2	2	3	3	2	2	2	3
CO3	3	3	2	2	3	3	2	2	3	3	2	2	2	3
CO4	2	2	3	2	2	3	2	2	3	3	2	2	2	3
CO5	3	1	2	2	3	2	2	1	3	3	1	2	2	3
CO6	2	1	3	1	3	2	3	3	2	2	1	3	3	2
CO AVG	2	2	3	2	3	3	2	2	3	3	2	2	2	3

Justification:

CO1	Attain comprehensive knowledge about Inset Feed Microstrip Antennas and their relevance in 5G technology.
CO2	Analyze challenges and propose solutions for integrating Inset Feed Microstrip Antennas into 5G systems based on extensive literature review.
CO3	Systematically design and develop Inset Feed Microstrip Antennas optimized for 5G, addressing complexities and ensuring functionality.
CO4	Construct and articulate prototypes/simulations validating the design of Inset Feed Microstrip Antennas for 5G applications.
CO5	Create sustainable solutions meeting societal needs, fostering individual and cooperative learning for enhanced antenna performance.
CO6	Efficiently execute the antenna design project within set timeframes and financial constraints for successful 5G integration.

Justification for PO & PSO mapping for Project:

Project Title		Design and Implementation of Inset Feed Microstrip Antenna Design for 5G Applications
PO ↓	Levels 3/2/1	Justification
PO1	3	Engineering Knowledge: Antenna design requires expertise in electromagnetics, RF engineering, materials, simulation tools, math for analysis, hands-on testing, system integration, and understanding of HFSS software.
PO2	2	Problem Analysis: Formulate a comprehensive analysis of the challenges associated with 5G communication, incorporating insights from relevant research literature to design an Inset Feed Microstrip Antenna that addresses these complexengineering problems.
PO3	2	Design/development of solutions: In antenna design, developing solutions involves crafting antennas that address complex engineering challenges while meeting specific requirements such as performance, efficiency, and bandwidth. This process must consider public health, safety, and compliance with cultural, societal,and environmental standards.
PO4	2	Conduct investigations of complex problems: Implement research-based knowledge and cutting-edge research methods in the investigation of complex problems related to 5G communication, employing design of experiments and data analysis to derive valid conclusions for refining the Inset Feed Microstrip Antennadesign.
PO5	3	Modern tool usage: Modern antenna design relies heavily on sophisticated engineering and IT tools for prediction and modeling. Software like HFSS, CST Studio Suite, and MATLAB are used for electromagnetic simulation, optimization,and analysis.
PO6	2	The engineer and society: Evaluate societal implications and ethical considerations in the development of the Inset Feed Microstrip Antenna, addressing health, safety, and cultural issues relevant to 5G technology, and acknowledging the professionalresponsibilities associated with its deployment.
PO7	2	Environment and sustainability: Sustainable antenna design involves understanding the environmental impact and striving for solutions that are eco- friendly. This can include using materials that are less harmful to the environment, designing for energy efficiency, and considering the lifecycle and recyclabilityof the antennas.

PO8	2	Ethics: Adhere to ethical principles in the design and implementation of the Inset Feed Microstrip Antenna for 5G applications, ensuring alignment with professional ethics and engineering norms to uphold integrity and responsibility in engineering practice.
PO9	3	Individual and Team Work in Antenna Design: Effective antenna design often requires collaboration in diverse, multidisciplinary teams. This collaboration can involve working with engineers from different specialties, researchers, and other professionals.
PO10	3	Communication: Communicate proficiently with the engineering community and society concerning the Inset Feed Microstrip Antenna's design for 5G applications, producing comprehensive reports and documentation, delivering clear and engaging presentations, and ensuring effective dissemination of information.
PO11	2	Project Management and Finance: Apply engineering and management principles to oversee the project involving the design and implementation of the Inset Feed Microstrip Antenna for 5G, handling resources efficiently, managing timelines, and coordinating tasks within multidisciplinary teams to ensure project success.
PO1 2	1	Life-long Learning in Antenna Design: The field of antenna design is rapidly evolving with technological advancements. This lifelong learning attitude ensures that antenna engineers remain at the forefront of innovation and technological development.
PSO 1	2	Design, develop, and integrate electronic circuits and systems using current practices and standards:Innovating electronic circuitry within industry guidelines, this outcome focuses on creating cutting-edge circuits, rigorously testing prototypes, and optimizing designs for optimal performance.
PSO 2	2	Apply knowledge of hardware and software in designing embedded and communication systems: This outcome centers on seamlessly integrating hardware and software components for robust embedded systems, proficiently developing embedded software, and ensuring efficient communication system integration.

Budget Estimation Sheets

Batch Number: B-30

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1DS20EC226	U. DEVENDRA KUMAR
1DS20EC243	Y. V. GIREESH KUMAR
1DS21EC421	SAI SUHAS Y

Budget Estimation:

Sl. No.	Particulars	Estimated Cost in Rs.
1	ANSYS Student Version(Free)	0
2	ROGERS RO3006 Material (shipping Charges)	1500
3	Fabrication	3000
4	SMA Connector	500
	Total	5000