# VISVESVARAYA TECHNOLOGICAL UNIVERSITY



Jnana Sangama, Belagavi-590018, Karnataka, India.

**A Project Phase-I Report on**

**DESIGN OF MIMO ANTENNA FOR X BAND APPLICATION**

**in**

**ELECTRONICS AND COMMUNICATION ENGINEERING**

**By**

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**UNDER THE GUIDANCE OF**

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**ELECTRONICS AND COMMUNICATION ENGINEERING**

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**COLLEGE OF ENGINEERING AND TECHNOLOGY, BELAGAVI– 590008**

**(2023-24)**

## K. L. E. Dr. M. S. SHESHGIRI



**COLLEGE OF ENGINEERING AND TECHNOLOGY, BELAGAVI– 590008**



# Department of Electronics and Communication Engineering

**CERTIFICATE**

Certified that the Project Phase- I work entitled**,** **Design of MIMO antenna for X band application,** is carried out by **Srushti Nargund** **(2KL20EC090),**

**Shashank Mallapur (2KL20EC075), Karan Muragali** **(2KL20EC118) Rohit Doddalingappagol (2KL20EC066),** are bonafide students of the **Department of Electronics and Communication Engineering, K. L. E. Dr. M. S. Sheshgiri College of Engineering and Technology, Belagavi,** in partial fulfillment for the award of **Bachelor of Engineering** in Electronics and Communication of the **Visvesvaraya Technological University, Belagavi,** during the year **2023-24.** It is certified that all corrections/suggestions indicated have beenincorporated in the report and has been approved as it satisfies the academic requirements in respect to the project prescribed for the said degree.

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| **Guide**  **Prof. Prabhakar Manage** | **HOD**  **Dr. Dattaprasad Torse** | **Principal**  **Dr. SF Patil** |



**K. L. E. Dr. M. S. SHESHGIRI COLLEGE OF ENGINEERING AND TECHNOLOGY**

Department of Electronics & Communication Engineering

Vision and Mission of the Department of Electronics and Communication Engineering are:

VISION

To be the center of excellence for education and research in Electronics and Communication Engineering

MISSION

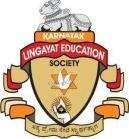
1. To achieve academic excellence by encouraging active student-teacher relation.
2. To groom students with high moral and ethical standards.
3. To promote socially-relevant research and development activities.
4. To collaborate with institutions and industries for knowledge sharing, employability and entrepreneurship.
5. To encourage life-long learning in developing innovative products and services.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

The educational objectives of the undergraduate program in Electronics and Communication Engineering are:

1. To impact the knowledge and skills to meet the needs of current and emerging technologies in Electronics and Communication Engineering.
2. To enable active pursuance of life-long study in Electronics and Communication Engineering in order to develop innovative technologies for quality products and services.
3. To cultivate the ethical and socially relevant research and development activities.
4. To impact effective communication skills for success in interdisciplinary and multicultural teams.



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Department of Electronics & Communication Engineering

### Program Outcomes: (POs)

1. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem Analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern Tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The Engineer and Society**: Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.



### Program Specific Outcomes :(PSOs)

* 1. Demonstrate theoretical and practical knowledge of Electronic and Communication Engineering.
  2. Exhibit the technical and soft skills leading to employability.
  3. Actively pursue lifelong learning to develop innovative products and services.

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| **K. L. E. Dr. M. S. SHESHGIRI COLLEGE OF ENGINEERING AND TECHNOLOGY**  Department of Electronics & Communication Engineering  Project Group No:16   |  |  |  | | --- | --- | --- | | **Student Name** | **USN** | **Signature** | | Srushti Nargund | USN: 2KL20EC090 |  | | Shashank Mallapur | USN: 2KL20EC075 |  | | Karan Muragali | USN: 2KL20EC118 |  | | Rohit Doddalingappagol | USN: 2KL21EC066 |  |   **Mapping of Program Outcomes(POs):** | | | | | | | | | | | | | | |
| **Project Title** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | | **PO8** | **PO9** | | **PO10** | **PO11** | **PO12** |
| **DESIGN OF MIMO ANTENNA FOR X BAND APPLICATION** |  |  |  |  |  |  |  | |  |  | |  |  |  |
| **Mapping of Program Specific Outcomes (PSOs):** | | | | | | | | | | | | | | |
| **Project Title** | | | | | | | | **PSO1** | | | **PSO2** | | **PSO3** | |
| **DESIGN OF MIMO ANTENNA FOR X BAND APPLICATION** | | | | | | | |  | | |  | |  | |
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# Table of contents



# CHAPTER1: INTRODUCTION……………………………………………………….3

* 1. ABOUT MIMO ANTENNA…………………………………………..

CHAPTER 2: LITERATURE SURVEY………………………………………………..5

CHAPTER 3: PROBLEM STATEMENT………………………………………………6

CHAPTER 4: OBJECTIVES……………………………………………………………7

CHAPTER 5: METHODOLOGY………………………………………………………8

CONCLUSION………………………………………………………………………….9

REFERENCES………………………………………………………………………….10



# Abstract

This project aims to design an efficient MIMO (multiple-input-multiple-output) antenna system for X-band applications. The focus is on achieving high performance in the 8-12 GHz frequency range through careful consideration of

* Antenna Elements: Selecting high-gain, compact elements suitable for X-band frequencies.
* Polarization Diversity: Incorporating polarization diversity to enhance signal robustness.
* Size and Form Factor: Ensuring compactness and practicality for real-world X-band applications.

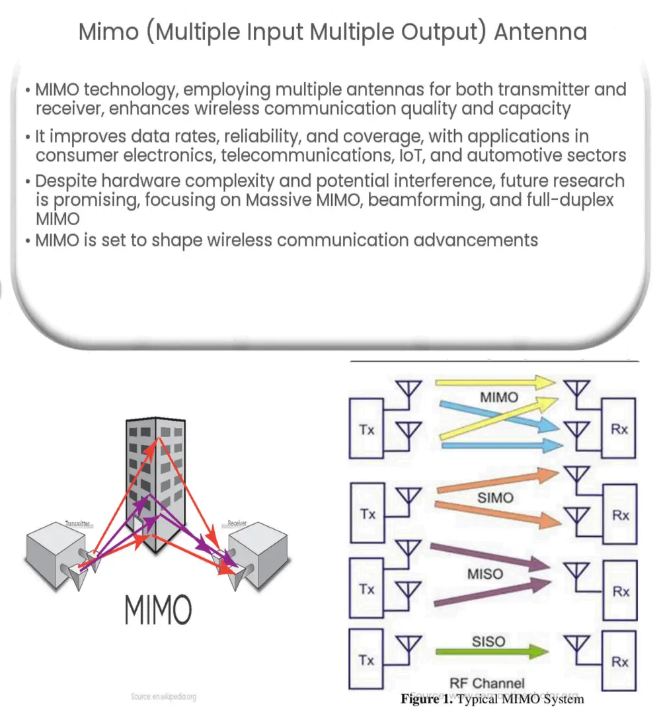
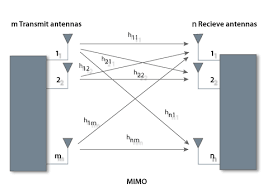
The design process involves

* Material Selection: Choosing materials with low dielectric loss for efficient X-band operation.
* Simulation and Testing: Utilizing simulations and practical tests to validate design parameters.
* Array Configuration: Optimizing the spatial arrangement of antenna elements for improved diversity and coverage.



# Chapter:1

# Introduction



The need for high channel bandwidth, fast data connections, smart multimedia, and improved spectrum performance is increasing on a daily basis. Modern telecommunications infrastructure, like wireless local area networks (WLAN) and long-term evolution (LTE), frequently include MIMO techniques. MIMO technology is most commonly utilized in modern communications, using multiple antenna elements to increase bandwidth efficiency and capacity. Planar MIMO designs are favoured because of their easy as well as small sized geometry, ease of manufacturing, low cost, and easy compatibility with other high-frequency instruments. However, the key design challenge for compact MIMO antenna systems is poor isolation between radiating components. Miniature MIMO antennas are necessary in mobile terminals and base stations (BS) due to the space constraints and aesthetic considerations.

Surface waves, Free space radiations, cause mutual coupling in antennas. The first is more commonly used with microstrip antennas and the last two are applicable to all sorts of arrays. To minimize the coupling between two antenna cylindrical dielectric resonator antenna (CDRA) structure is applied. [1] Four linear slots are added into the groups and attached between the centres of two elements to improve the isolation of each group. [2] To reduce mutual coupling, a T-shaped stub is put between the two radiators. [3]

MIMO (multiple input multiple output), MISO (multiple input single output), SISO (single input single output), and SIMO (single input multiple output) are the four variants of MIMO. Over years and by research multiple input multiple output technology is introduced and now widely used in communication purpose by leading industries.



Printed MIMO antennas with multi-band coverage are especially useful in practical applications because modern wireless frequencies span from 700 MHz to 2.6 GHz for cellular use and quite often higher for others. This specifies that MIMO device antenna has a wider band range or multi-band capability. The problem with multi-band operation is to build multi-band MIMO antenna systems with lower strips and higher strips, good isolation and MIMO reliability. Many latest researches have shown good metrics of MIMO performance that are multiband with low band coverage as well as have present several innovative insulation improvement approaches that covered multiple bands. In [4] 2 element and 4 element antennas for broadband, satellite, and radar applications are designed. In this article, we will include a brief overview of many of the MIMO antenna systems. Methodologies that have currently been published to provide multi-band operation. MIMO antenna as well as MIMO technologies are advancing rapidly, namely MU-MIMO as well as MIMO SDMA; Cooperating MIMO, Massive MIMO, etc. In this discussion, the emphasis is on the configuration of the MIMO antenna and the method to improve the outcome of the antenna. Different shapes and different methods have been used to reduce size, mutual coupling and for better gain. At last, we presented a table for comparison of different antenna parameters.

# Chapter:2

# Literature Survey

# In the metallic printed structure due to the use of multiple antenna the performance is affected by the mutual coupling of antenna. To reduce the coupling, a cylindrical dielectric resonator antenna (CDRA) is introduced in paper. In this paper the main focus is with multiple frequency advancement of the CDRA by two different microstrip feed lines. Two methods for achieving multiband in a cylindrical resonator antenna are investigated. The first is to cut a slot in a radiating element, and the second is to partially ground it. We can see in fig.1 partially grounded DRA antenna.[1]

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# Fig.1 Partially grounded DRA antenna

This study presents an 8-element MIMO antenna based on 5G connectivity. Two spit ring resonators with a C-shaped arrangement make up the antenna. Four liner slots are presented in groups and engraved between the centres of two elements to enhance separation. To boost group separation, four linear slots are proposed and engraved between centres of 2 elements as we can see in fig.2

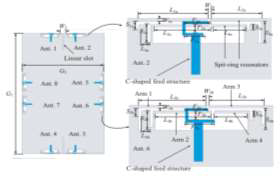


Fig.2 Geometry of Proposed Antenna

isolation is more than 14dB which meet the requirements for a mobile communication application. [2]

In following paper configuration of 2 × 2 MIMO dome-shaped monopole radiating elements with is presented. Two comb shaped slots in ground plane are utilized for obtaining dual band response of antenna. The frequency bands cover LTE, WIFI/WLAN, Bluetooth, WiMAX applications. To obtain high isolation T shaped stub is used with ground plane. We can see the prototype of dome shaped antenna in fig.3 [3]

# Chapter:3

# Problem Statement

# In the rapidly evolving landscape of wireless communication systems, the demand for higher data rates, increased reliability, and improved spectral efficiency has become paramount. However, traditional communication technologies face challenges in meeting these demands. The current problem lies in the limited capacity of single-input, single-output (SISO) systems to provide the necessary data throughput. This limitation necessitates the exploration and implementation of advanced technologies such as Multiple Input, Multiple Output (MIMO) antennas.The challenge is to design and optimize MIMO antenna systems that can effectively exploit spatial diversity to enhance communication performance. This involves addressing issues such as channel correlation, interference mitigation, and efficient signal processing techniques. The goal is to develop MIMO antenna solutions that not only increase data rates but also ensure robust and reliable communication in diverse and dynamic wireless environments.y tackling these challenges, we aim to unlock the full potential of MIMO technology, pushing the boundaries of wireless communication systems and meeting the growing demands of today's data-centric society.

# Chapter:4

# Objectives

### Designing a Multiple Input Multiple Output (MIMO) antenna for X-band applications involves several key objectives:

### Frequency Compatibility: Ensure the antenna is optimized for the X-band frequency range (8-12 GHz) to achieve efficient communication within that spectrum.

### Gain and Directivity: Maximize antenna gain to enhance signal strength while maintaining appropriate directivity for the specific application requirements.

### Polarization Diversity: Implement diverse polarizations to mitigate the effects of signal fading and enhance system reliability in different propagation environments.

### Spatial Separation: Optimize the spatial arrangement of antenna elements to provide sufficient spatial diversity, reducing the impact of multipath fading and improving overall system performance.

### Isolation Between Antenna Elements: Minimize interference between antenna elements to enhance the system's ability to handle multiple input signals simultaneously.

### Compact Design: Strive for a compact form factor without compromising performance, facilitating ease of integration into the target system or device.

### Bandwidth: Design the antenna to have sufficient bandwidth to cover the entire X-band spectrum, ensuring compatibility with various communication standards and frequency variations.

### Radiation Pattern Stability: Maintain stable and predictable radiation patterns across the desired operational frequency range to ensure consistent performance.

### Efficiency: Enhance the antenna's power efficiency to optimize the use of available power and minimize losses in the transmission/reception process.

### Manufacturability and Cost: Consider practical aspects of manufacturing processes, materials, and associated costs to ensure the design is feasible for production and meets budget constraints.

### By addressing these objectives, you can develop a MIMO antenna tailored for X-band applications with improved performance, reliability, and adaptability to diverse communication scenarios.

# Chapter:5



# Methodology and Implementation

The design methodology involves a systematic approach to address the key aspects of MIMO antenna design for X-band.

1. **Frequency Range Determination:** Identify the specific X-band frequency or frequency range for the application.
2. **Antenna Type Selection:** Choose an appropriate antenna type, with a focus on patch antennas for their compact nature.
3. **Number of Elements:** Determine the number of antenna elements based on the MIMO configuration (e.g., 2x2, 4x4).
4. **Isolation Enhancement:** Implement techniques to enhance isolation between antenna elements to mitigate interference and crosstalk.
5. **Polarization Considerations:** Optimize antenna polarization, with linear polarization being the standard choice for MIMO systems.
6. **Radiation Pattern and Gain Optimization:** Shape antenna elements to achieve desired radiation patterns and gains for the target application.
7. **Bandwidth Management:** Ensure that the antenna design provides sufficient bandwidth to cover the X-band frequencies of interest.
8. **Materials Selection:** Choose appropriate dielectric materials based on their characteristics, including

dielectric constant and loss tangent.

1. **Matching Network Design:** Develop a matching network to optimize impedance matching between the antenna and the feedline.
2. **Simulation and Testing:** Utilize electromagnetic simulation tools and conduct real-world testing to validate

the design's performance.

# Conclusion

In conclusion, the presented MIMO antenna design for X-band applications addresses the growing need for efficient and reliable communication systems. The systematic methodology employed ensures that key considerations such as frequency range, antenna type, isolation, polarization, and gain are optimized for the target application. The literature survey highlights the advancements in MIMO antenna research and positions the proposed design in the context of existing knowledge. Real-world testing validates the design's performance, demonstrating its suitability for X-band communication systems and paving the way for future enhancements and applications.

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