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Following students have carried out their Project work/ Internship/ Field Project/Industrial Training for the academic session 2021-22

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02.	Manish Deshmukh	7-11

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Signature and Seal of the Head

A

Dissertation Report

on

WIDEBAND METAMATERIAL STRUCTURE FOR WIRELESS APPLICATIONS

Submitted for the partial fulfilment for the award of degree

of

MASTERS OF TECHNOLOGY

in

Electronics and Communication Engineering

By

ABHIJEET AGRAWAL

(ROLL NO. 21031101)

M.Tech. III semester

Under the Guidance of

Dr. Soma Das

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

SCHOOL OF STUDIES OF ENGINEERING AND TECHNOLOGY

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(A Central University)

SESSION 2023-2024

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
SCHOOL OF STUDIES IN ENGINEERING AND TECHNOLOGY
GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR

DECLARATION

I hereby declare that the Dissertation report work entitled "**Wideband Metamaterial structure for Wireless Applications**" submitted to Guru Ghasidas Vishwavidyalaya, Central university, Bilaspur, C.G. is a record of an original work done by me under the guidance of **Dr Soma Das** Associate Professor, Department of Electronics and Communication Engineering, Guru Ghasidas Vishwavidyalaya, Central University, Bilaspur, Chhattisgarh.

This Dissertation report work is submitted in partial fulfillment of the requirement for the award of the degree of Masters of Technology in Electronics and Communication Engineering.
The result embodied and this thesis has not been submitted to any other university or institute for the award of any degree or diploma.

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I would like to express my special gratitude and thanks to my colleagues in developing the project and people who have willingly helped us.

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CERTIFICATE

This is to Certified that the dissertation entitled " **WIDEBAND METAMATERIAL STRUCTURE FOR WIRELESS APPLICATION** " submitted by **ABHIJEET AGRAWAL** in partial fulfillment of the requirements of the award of the degree of Master of Technology in Electronics and Communication Engineering, School of Studies of Engineering & Technology, Guru Ghasidas Vishwavidyalaya, Bilaspur (C.G.) is accorded to the student's own work, carried out by him in the Department of Electronics and Communication Engineering during the session 2022-2023 under supervision and guidance.

Dr. Soma Das

Professor
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Dr. SOMA DAS

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CHAPTER 1

INTRODUCTION AND OVERVIEW

Wireless devices became a basic necessity nowadays for human beings, transmitting a signal is done through radio waves which are transmitted and received through an Antenna. Antennas work by converting electrical signals into electromagnetic waves and vice versa. When an electrical signal is fed into an antenna, it generates an electromagnetic field that radiates outwards, carrying information with it.

The performance of an antenna depends on various factors, including its size, shape as well as frequency of the waves it is designed to transmit or receive. Different frequency range is allotted for different applications. WLAN frequency is considered for various wireless applications such as WiFI, Bluetooth, etc. A single antenna has a smaller channel capacity to transmit and receive information to increase channel capacity and data rate we opt for Multiple Input Multiple Output (MIMO). In MIMO multiple antennas are used to transmit and receive radio waves. Mutual coupling occurs when the antenna is nearby placed. When radiation is absorbed by a nearby antenna when one antenna is operating this is called Mutual coupling and to minimize coupling between the antennas different decoupling techniques are proposed e.g., Defected ground structure (DGS) [1], Split rig resonator [2], Complement split ring resonator (CSRR) [3], Electromagnetic Bandgap structure (EBG) [4], Neutralization lines [5], Different geometric elements [6].

Apart from them, metamaterial is one of the effective solutions to reduce mutual coupling. Metamaterials are artificially engineered materials designed to manipulate EM waves. Any possible design can be considered as metamaterial if it exhibits negative refraction or backward wave propagation properties.

"The dielectric constant ε and the magnetic permeability μ are the fundamental characteristic quantities which determine the propagation of electromagnetic waves in the matter". In the year 1968 Russian physicists firstly presented simultaneously negative permittivity and permeability [7]. But it was not considered valid till 2000 when D. R. Smith experimentally presented the same characteristics [8]. A negative refractive index in metamaterials is achieved by constructing sub-wavelength structures that interact with incident electromagnetic waves in a specific way. This interaction creates a negative effective refractive index for the material, which leads to negative refraction of electromagnetic waves. The Metamaterial structures can be used in many fashions in order to get desired results. It can be used as superstrate by placing MTM structure above the antenna and can be placed on same plane in which antenna is placed.

A

Dissertation Report

On

PERFORMANCE ENHANCEMENT OF MIMO ANTENNA

SUBMITTED
BY

MANISH DESHMUKH

(Enrollment No.-GGV/17/1124)
Roll No.-21031102

M.Tech. III Semester

Under the Guidance of

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Session: 2022-2023

DECLARATION

We the undersigned solemnly declare that this report of dissertation work, entitled " **PERFORMANCE ENHANCEMENT OF MIMO ANTENNA** " is my work, carried out during the 3rd semester under the guidance of **MR. Sumit Kumar Gupta** (Assistant professor) Department of **Electronics and Communication Engineering, School of Studies of Engineering & Technology, Guru Ghasidas Vishwavidyalaya Bilaspur (C.G.).**

We assert that the statements made and conclusions drawn are the outcomes of our work. We further declared that this project work is representing the learning experience during the course.

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(A Central University Established by the Central University Act No. 25 of 2009)

CERTIFICATE

Certified that the dissertation entitled " **PERFORMANCE ENHANCEMENT OF MIMO ANTENNA** " submitted by **MANISH DESHMUKH** in partial fulfillment of the requirements of the award of the degree of Master of Technology in Electronics and Communication Engineering, School of Studies of Engineering & Technology, Guru Ghasidas Vishwavidyalaya, Bilaspur (C.G.) is accorded to the student's own work, carried out by him in the Department of Electronics and Communication Engineering during the session 2022-2023 under supervision and guidance.

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1. INTRODUCTION

The desire for faster transmission and reception of information has fueled the rapid progress of wireless technology. The evolution of antennas started in the late 1800s with the discovery of electromagnetic waves by James Clerk Maxwell[1]. Over the past few decades, wireless communication systems have evolved from the first generation (1G) of Wireless communication, these antennas were omnidirectional and had a wide beam width, which made them suitable for communication over short distances[2]. to the introduction of digital mobile networks in the 1990s, the second generation (2G) of mobile networks saw the introduction of smaller, more efficient antennas. These antennas were designed to support the transmission and reception of digital data, including text messages and basic internet connectivity. [3]. Further, it improved the multimedia-capable third-generation (3G) mobile networks[4], introduced in the early 2000s, and introduced more advanced antennas, such as the microstrip patch antenna. This type of antenna is highly efficient and can be easily integrated into small, portable devices[5]. Fourth-generation (4G) wireless communication systems utilize multiple-input and multiple-output (MIMO) technology to further increase data transmission rates [6]. MIMO technology can significantly enhance channel capacity by linearly increasing the number of antennas without requiring additional frequency spectrum [7]. but Ultra-wide-band (UWB) technology has become increasingly popular in the wireless industry after the US Federal Communication Commission (FCC) authorized the use of unlicensed frequencies ranging from 3.1 to 10.6 GHz for indoor applications and handheld devices in 2002[8]. UWB communication systems offer numerous benefits such as high-speed data transfer with high power efficiency, low complexity, low cost, and high precision[9]. However, these systems are susceptible to multipath fading effects that are caused by signal reflection and diffraction[10], [11]. Fortunately, in multiple-input multiple-output (MIMO) systems, both the transmitter and receiver are equipped with multiple antennas to transmit and receive signals with varying fading properties[12]. This approach provides multiplexing gain and diversity gain, which enhances channel capacity and reliability, respectively [13]. There are various types of antennas that can be used for MIMO (Multiple Input Multiple Output) systems. The most common types of antennas used in MIMO systems are: