A logo with a black background

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**Department of Electronics and Electrical Communication Engineering.**

**Faculty of Engineering Cairo university**

**Antenna Project**

Cairo University - Faculty of Engineering

Electronics and Communications Engineering Department

**ELC 3050 – Fall 2024**

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# Introduction and Problem description

## Introduction

Microstrip Patch Antennas (MPAs) are widely used in modern wireless communication systems due to their low-profile, lightweight, and ease of integration with other circuit components. These antennas are particularly useful in high-frequency applications such as 5G and millimeter-wave (mm Wave) communications, where bandwidth demand and system performance are critical.

A microstrip patch antenna typically consists of a conducting patch placed on a dielectric substrate with a ground plane on the opposite side. The shape of the patch, the substrate material, and the dimensions are chosen to meet specific resonance conditions, providing efficient radiation at a given frequency.

In this project, the focus is on designing a **two-element array** of **slot-fed microstrip patch antennas** operating at a frequency of **26 GHz**, which is a key frequency band for 5G and future wireless communication systems. The array configuration aims to improve the antenna's gain and directivity, essential for high-frequency applications that require precise and high-performance communications.

## Problem description

The goal of this project is to design and analyze a two-element array of slot-fed microstrip patch antennas operating at 26 GHz. The primary objective is to achieve the desired radiation characteristics, including a specific gain, directivity, and impedance matching, while also addressing the challenges associated with high-frequency operation.

Key aspects of the project include:

1. **Antenna Design**: Design of individual slot-fed microstrip patch antennas, including the selection of patch shape, size, and dielectric material to ensure resonance at 26 GHz.
2. **Slot Feeding**: The use of slot feeding for the antenna, where the excitation is achieved through a slot in the ground plane. This method offers benefits such as reduced spurious radiation and better impedance matching.
3. **Array Configuration**: The two-element array configuration must be designed to achieve constructive interference, enhancing the antenna’s gain and directivity. The array elements must be spaced appropriately to prevent undesirable interference or mutual coupling.
4. **Impedance Matching**: Ensuring that the antenna’s impedance is matched to the transmission line to maximize power transfer and minimize reflections at the operating frequency of 26 GHz.
5. **Simulation and Optimization**: Using simulation software (such as CST Microwave Studio, HFSS, or others) to model the antenna array, simulate its performance, and optimize its design for optimal radiation characteristics.
6. **Performance Analysis**: Evaluating the antenna array’s performance based on parameters such as return loss, gain, radiation pattern, and bandwidth to ensure that it meets the specifications for 26 GHz operation.

The problem involves not only designing the antenna itself but also considering the effects of the operating frequency, material properties, and array configuration on overall performance. Additionally, challenges such as minimizing loss, optimizing the array layout, and managing mutual coupling between elements must be addressed.

By successfully designing this two-element array of slot-fed microstrip patch antennas, the project aims to contribute to the development of efficient antenna solutions for high-frequency applications in next-generation communication systems, such as 5G and beyond.

# Design Procedure

## Verification of EM tool results

In this section we are willing to verify the EM tool results by benchmarking against another well-Known source. So, we designed a dipole and observed the output if it’s close to the excepted one ideally.

We used the material of the antenna (dipole) as copper and the radiation medium is air.

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Figure : dipole structure

In the first simulation we adjusted the diameter of the dipole to and its length to and the gap between the two wires - due to the supposed feeding – to .

Due to the length we have for the dipole we will get the resonance frequency as follows:

, .

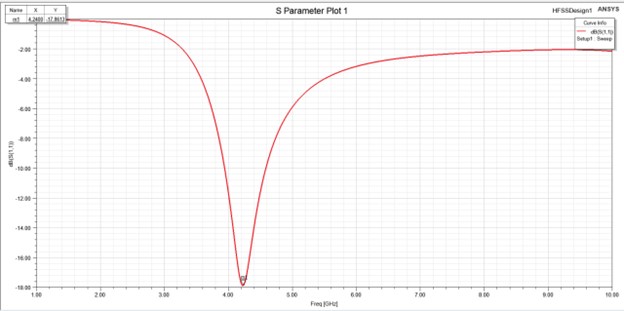


Figure : dipole return loss

As we see, it is near to the desired frequency but due to the non-ideality we have due to the gab between the two wires and the wire diameter which are both ideally zero, so we reduced them to the minimum possible values for the mesh size.

The new parameters values are and the gap

## Gain

# Results and Discussion

# Final Design Layout

# Conclusion

# References

1. <https://www.jpier.org/issues/volume.html?paper=23102602>
2. <https://www.researchgate.net/publication/339256389_Design_and_simulation_of_26_GHz_patch_antenna_for_5G_mobile_handset>