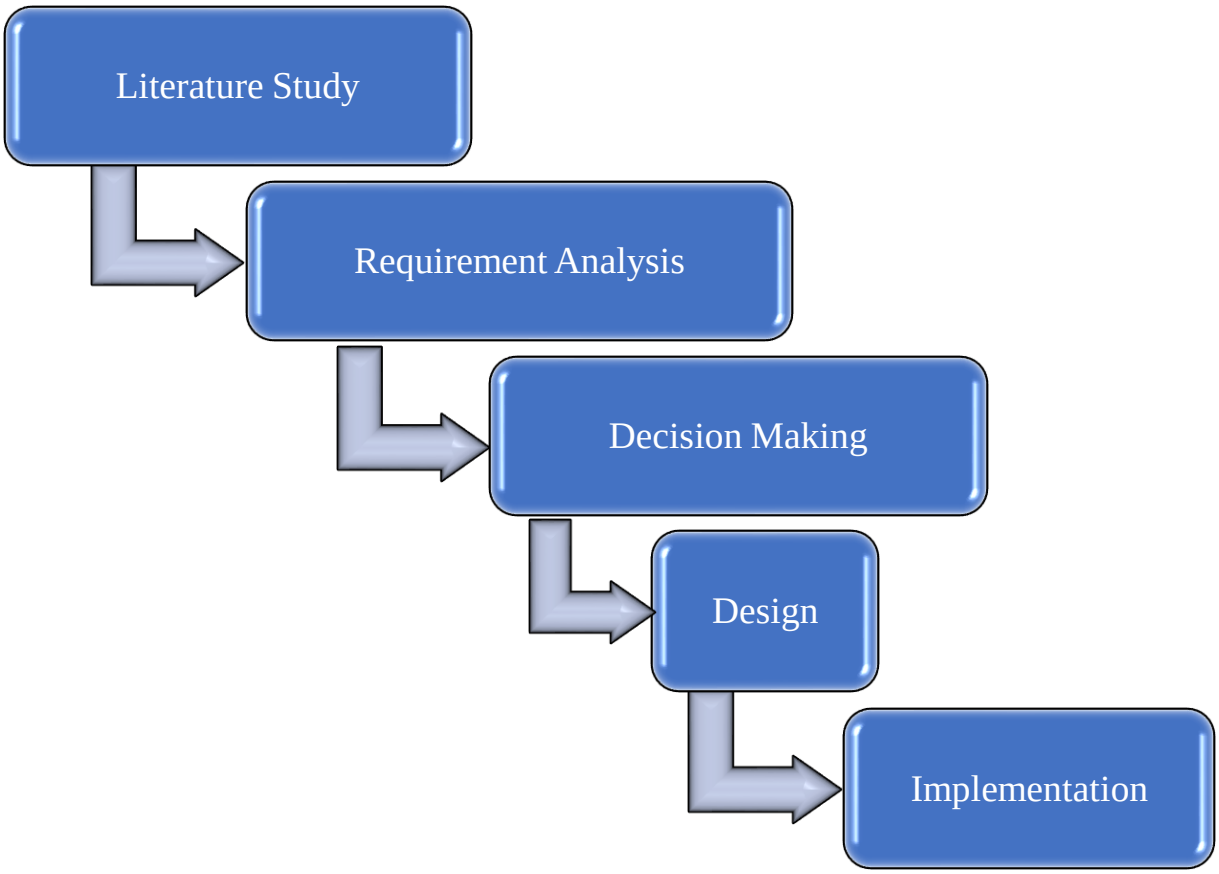
"We would like to thank Prof. A.K.Samanta for making us a part of his research work"

Objective: Designing an Antenna for portable devices with higher gain and smaller size.

Stages:



Step 1: Design an Antenna for portable devices.

Literature Study: Research Paper, Articles, Blogs.

Major Findings: Characteristics that differentiates: Gain, Directivity, Frequency, Radiation Pattern.

Mentor's Feedback: Proceed.

Step 2: Design and Analysis of Antenna based on Characteristics.

Literature Study: Research Paper, Articles, Blogs.

Requirement Analysis: Patch Antennas are most suitable.

Mentor's Feedback: Proceed.

Step 3: Design and Analysis of Patch Antenna based on Characteristics.

Literature Study: Research Paper, Articles, Blogs.

Problem Statement: Microstrip vs Stripline.

Shape of the Patch.

Decision Making: For minimum fabrication cost, Microstrip and Rectangular Shape.

Mentor's Feedback: Proceed.

Step 4: Design and Analysis of Rectangular Microstrip Patch Antenna.

Design: CST Studio Software is used. FR4 substrate is required(Height-1.5mm, dielectric constant-4.3, minimum and maximum frequency of 2.0-2.8GHz respectively).

Mentor's Feedback: Proceed.

Step 5: Final implementation done on CST and results are shown.

Frequently Asked Questions

1. Major characteristics for Antenna's classification:

- Gain: Antenna gain is how much an antenna focuses radio waves in a particular direction, like a flashlight beaming light in one direction instead of scattering it everywhere.
- Frequency: An antenna's frequency is the rate at which it oscillates in transmitting or receiving electromagnetic waves, measured in Hertz (Hz).
- Radiation Pattern: An antenna's radiation pattern describes how its signal strength varies in different directions around it, typically measured in decibels (dB).
- Directivity: Antenna directivity is how much an antenna concentrates radio waves in a specific direction, measured in dBi (decibels relative to an isotropic radiator).

2. Major Antennas based on characteristics:

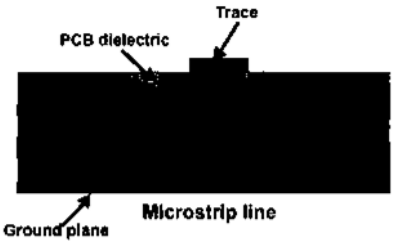
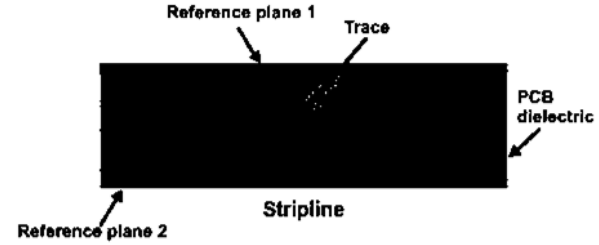
- Dipole Antenna:
- Loop Antenna:
- Monopole Antenna:
- Yagi-U-da Antenna:
- Horn Antenna:
- Patch Antenna:

	A	B	C	D	E
1	**NAME**	**GAIN(dBi = 10log(ηD))**	**DIRECTIVITY**	**FREQUENCY**	**Radiation Pattern**
2	**DIPOLE antenna**	1.64 (2.15 dBi)	1.64 or 2.15 dBi.	2.2 GHz.	omnidirectional antenna
3	Straight Dipole Antenna	1.5 (1.76 dBi)	1 (or 0 dB).	216 MHz	omnidirectional antenna
4	Folded Dipole Antenna	2.735 and 2.989 dB	2.15 dBi;	300MHz	Omni-directional antenna
5	Bowtie Dipole Antenna	1.5 (1.76 dBi)	1 db	120 MHz	Omni-directional antenna
6	Discone Antenna	1.75 to 2.3 dBi.	1 (or 0 dB).	862 MHz	Omni-directional antenna
7	**LOOP ANTENNA**	8.2 dBi.	1.5 (1.76 dB)	3GHz	Omni-directional antenna
8	Circular Loop Antenna	3.694dB	1 dbi	90MHz.	Omni-directional antenna
9	Rectangular Loop Antenna	7.5 dBi	1 dbi	53 MHZ	Omni-directional antenna
10	Elliptical Loop Antenna	4.4dbi	1.5 dbi	30 MHz	Omni-directional antenna
11	Helical Loop Antenna	2.5 dB	1 dbi	3GHz	Omni-directional antenna
12	**MONOPOLE ANTENNA**	2.15 dBi	4.2dB	2 GHz	Omni-directional antenna
13	Whip Antenna	4 dBi	2.15 dBi;	1.9 GHz	Omni-directional antenna
14	Planar Monopole Antenna	4.9 dBi	1.25 dbi	900 MHz	Omni-directional antenna
15	**YAGI-UDA ANTENNA**	20 dBi	10 dBi	3GHz	directional antenna
16	**HORN ANTENNA**	25 dBi	20 dB	20 GHz	Omni-directional antenna
17	**PATCH ANTENNA**	9 dBi	5-7 dB	2.4 GHz	Omni-directional antenna
18	Rectangular Patch Antenna	5.6692 dB	5-7 dB	5.2 GHz	Omni-directional antenna
19	Square Patch Antenna	9.179 dB	5-7 dB	2.4 GHz	Omni-directional antenna
20	Circular Patch Antenna	3 dB	5-7 dB	2.42 GHz	Omni-directional antenna
21	Triangular Patch Antenna	2.9 dB	5-7 dB	2.4 GHz	Omni-directional antenna
22	Hexagonal Patch Antenna	5.32 dB	5-7 dB	10.6 GHz	Omni-directional antenna

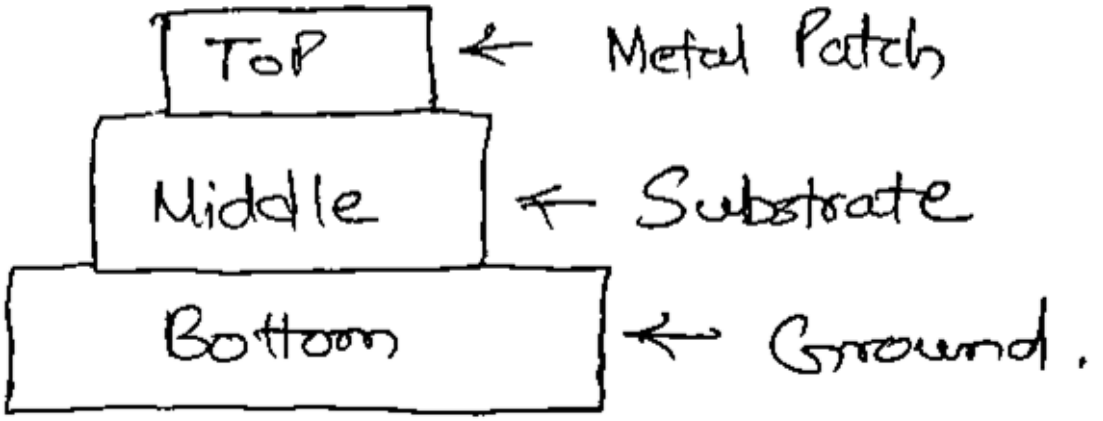
3. Why Microstrip over Stripline?

Advantages:

- Less Expensive
- More Compact
- Suitable for Integration
- Ease of fabrication on PCBs.

Microstrip	Stripline
	
The signal conductor is placed on the outer layer of a PCB, with a ground plane underneath the substrate	The conductor is sandwiched between two dielectric layers, with ground planes on both sides of the dielectric layers
Lower propagation constant (approximately 3)	Higher propagation constant, equal to substrate's D_k
Lower dieletric loss	Higher dieletric loss
Higher radiation loss	Lower radation loss
One side of the substrate is exposed and hence signal propagation is faster	Slower signal propagation due to the enclosed structure

- Smaller Dimension
- It radiates more power in a certain direction than another direction.
- Best fit for portable wireless devices.



4. Why Rectangular Microstrip Patch Antenna over others?
   - Improved Gain Value
   - Higher Return Loss: Return loss is a measurement parameter that expresses how well a device or line matches.
   - Maximum directivity in the direction perpendicular to the patch
   - They are commonly used in Portable Communication Systems.

5. Why FR4 substrate is used?
   - Excellent thermal, mechanical, and electrical properties making them perfect choice for a wide range of electronic applications.
   - Dielectric Constant (εr): FR-4 has a moderate dielectric constant typically around 4.4, which is suitable for microstrip patch antennas. The dielectric constant affects the wavelength of the signal in the substrate, which in turn influences the dimensions of the patch antenna. A moderate value like that of FR-4 allows for a good compromise between size and performance.
   - Cost-Effectiveness: FR-4 is a relatively inexpensive substrate material compared to other specialized substrates used in antenna design. This makes it a cost-effective choice for mass production or applications where cost is a significant factor.
   - Availability: FR-4 is readily available and commonly used in the electronics industry for printed circuit boards (PCBs). Its widespread availability makes it easy to source and work with for antenna designers.
   - Ease of Fabrication: FR-4 is easy to fabricate and work with, making it suitable for rapid prototyping and small-scale production. It can be easily cut, drilled, and etched to create the desired antenna structure.
   - Mechanical Strength: FR-4 is a robust material with good mechanical strength and dimensional stability. This makes it suitable for applications where the antenna may be subject to mechanical stress or environmental factors.
   - Temperature Stability: FR-4 has good temperature stability, which is important for maintaining the performance of the antenna across a range of operating conditions.

6. Why copper is used?

- It has exceptional electrical and thermal characteristics necessary for signal transmission and heat dissipation.