# CHAPTER I
# INTRODUCTION

## 1.1 Background

With technological advances in radar and signal processing, it is almost impossible to modify the shape of a target to reduce the radar cross section and avoid radar detection. Therefore, a new way to avoid radar detection is needed, using an absorber. Absorber or electromagnetic wave absorber or commonly referred to as absorber, is widely used to eliminate unwanted electromagnetic wave radiation that can interfere with the operation of a device or system. Electromagnetic waves emitted by a transmitter propagate in the air and can be perfectly absorbed by a layer or material if it has the same impedance as the air impedance [1]. Absorber can also be planar, by utilizing a textured surface with a certain structure, the absorber in planar form will have the property of absorbing electromagnetic waves, and can also be applied as an anti-radar material [2] - [4].

One method of creating an absorber is by using split-ring resonators. Split-ring resonators (SRR) consist of an array of resonators with a ring-like shape, which can be utilized as an absorber of electromagnetic waves. SRR has unique magnetic properties and can resonate at certain frequencies. This is due to the capacitance and inductance in the SRR [5]. SRR can produce absorbers with flexible dimensions and thin shapes [6]. Some recent research shows that SRR absorbers have shown good electromagnetic wave absorption performance over several frequency ranges, and have good absorption over a wide range of incident wave polarizations [7] - [11].

In [9], the absorber with SRR pattern was designed to work at 3.5 GHz and 5.8 GHz frequencies with a cell size of 13 mm and using FR-4 substrate type with a thickness of 2 mm, with an absorption rate above 95%. The SRR pattern with hexagonal shape studied in [10] has two absorption frequency ranges, with an absorption rate of more than 98%. In [11] the designed SRR absorber has two working frequency ranges at x-band. The absorber is designed with a dielectric material thickness of 1.8mm and produces an absorption rate of up to 100%. Research conducted in [12], designed an AMC-based absorber with a thin and flexible material, with silicon material, but still requires resistive components to improve its performance. A method for bandwidth improvement was proposed in [11], using the *double resonance* method, where two different sizes are used for one absorber cell. The design made in the study can produce bandwidth up to 500 MHz, using FR-4 substrate material. From the research that has been done, there is no thin and flexible absorber that can follow a surface area, so that the absorber can be applied in real life as an anti-radar coating material.

In this research, a thin SRR-based metamaterial absorber will be designed, and it has resistance to various angles of incident waves. So that the absorber can adapt to various shapes of the target surface and has a good absorption rate. In [12], a flexible silicon material with a thickness of 0.3mm was used, this material has lossy and flexible properties, making it attractive and suitable to be used as a dielectric material in this study. By using *polyimide*, which is a lossy dielectric material that is flexible and has a thickness of 0.3 mm to 0.6 mm, it has the potential to create a thinner absorber. In improving the absorption performance of electromagnetic waves, the *double resonance* method will be used, which can produce absorption of electromagnetic waves over a wide frequency range [11], [13].

## 1.2 Statement of the Problem

This research will focus on designing and realizing an absorber with a thin thickness and flexibility that allows it to follow the shape of a surface as well as having a wide bandwidth and resistance to various polarization angles of the incident wave. From previous research, it is known that SRR-based planar-shaped absorber has good absorption performance. But currently, the planar-shaped absorber is still too thick and rigid, making it less applicable for a good anti-radar coating material.

## 1.3 Objectives

The research will result in the design and analysis of an SRR-based metamaterial absorber that can follow various target shapes and also has a good absorption rate at various types of incident wave angles so that the absorber can be used as an optimal absorber. To produce a flexible absorber, the dielectric material used will have flexibility such as polyimide, and the double resonance method will be used to overcome the problem of absorption bandwidth in thin absorbers.

## 1.4 Scope of Work

The scope of work in this research is as follows:

1. The SRR absorber metamaterial utilizes the unique magnetic properties of the conductor structure with an arrangement consisting of symmetrical and periodically arranged ring pieces. This manipulates the permittivity and permeability values on the absorber surface to be negative and gives rise to electromagnetic wave absorption properties.
2. To create a thin and flexible absorber, polyimide dielectric material will be used. To overcome the bandwidth limitation of the planar absorber, the double resonance method will be used by creating 4 different sectors in 1 absorber cell.
3. The absorber is designed using flexible and thin dielectric materials (<0.6mm) The absorber must also have good performance at any angle of the incident wave.
4. The designed absorber will work in free space, and will perfectly absorb electromagnetic waves in the far field (plane wave). The designed absorber will be thin and flexible, so it can be used as an anti-radar coating material for various applications.

## 1.5 Hypothesis

To produce an applicable anti-radar coating material, an absorber material that has flexibility and good absorption performance is required. SRR-based absorbers have good absorption performance, perfect absorption rate, and good resistance to various wave polarizations [7]-[11]. To create a flexible anti-radar coating material, polyimide dielectric material is used, which is a thin and flexible lossy dielectric material [20]. To overcome the bandwidth limitation of the thin absorber, the double resonance method is used where one absorber cell is divided into four sectors consisting of two resonators that have adjacent resonant frequencies, so that the two absorption patterns obtained will combine and produce absorption with a wider bandwidth [11].

## 1.6 Research Methodology

The research began by conducting a literature study. The literature study was conducted to identify references as a method of making an absorber that is in accordance with the objectives of this research, starting from the resonator pattern, material selection, bandwidth widening method, simulation method, and analysis of the absorption performance of the absorber. After conducting an initial analysis of the absorber design, the initial absorber design will be made and simulated. Furthermore, the absorber design will be optimized to obtain parameters that match the specifications in this study. Then the absorber will be realized, and measurements will be taken.

## 1.7 Research Method

The techniques and methods used in this research include:

1. Metamaterial Absorber with Split Ring Resonator

   Split Ring Resonator (SRR) has unique magnetic properties and can resonate at certain frequencies. This is due to the capacitance and inductance on the surface generated from the SRR. SRR is a ring-shaped arrangement of resonators. This shape can produce electromagnetic wave absorbers with flexible dimensions and thin shapes. Some forms of SRR are also known to produce electromagnetic wave absorbers that have quite good performance for various wave polarization angles [3], [10], [12].
2. Double resonance method

   This method is a method used to widen the bandwidth of the absorber. One absorber cell consists of four sectors consisting of two resonators that have adjacent resonant frequencies, so that the two absorption patterns obtained will combine and produce absorption with a wider bandwidth [11], [13].
3. Structure and Materials

   The absorber designed will use a thin and flexible polyimide material. The top of the absorber is an arrangement of SRR conductors lining the dielectric material, and the bottom will be fully coated by conductor material (full ground).