

## Abstract

This thesis primarily focuses on the design, development, and analysis of some novel metasurface structures, and applying them for the performance enhancement of modern wireless communication systems. The designed metasurfaces can be employed for performance improvement of microstrip antennas which forms a crucial component of the radio frequency front end, to achieve frequency reconfiguration of antennas for cognitive radio applications, designing novel cross polarization converters, and linear-to-circular polarization converters for various wireless communication applications, and lastly to reduce the radar cross section (RCS) of antennas as well as planar and conformal surfaces for stealth applications.

In the first contributory work, it is demonstrated how a square shaped reactive impedance surface (RIS) can be employed for the performance improvement of a patch antenna in terms of size, bandwidth, and gain. The property of the RIS to spatially distribute the image representation that can minimize the mutual coupling between the antenna and its image can be used to improve the antenna bandwidth.

Metasurface structures can be employed for frequency reconfiguration of antennas for various applications one of which is cognitive radio application. In the second contribution, a two port antenna system comprising of an ultrawideband sensing antenna and a frequency reconfigurable dual band communicating antenna is presented which can be used for cognitive radio applications. Rotation of the metasurface layers changes the effective permittivity of the structure which alters the resonant frequency of the communicating antenna. Three states of operation are obtained to cover the entire sensed spectrum.

In the third contributory work, two types of ultrathin, reflective, wideband and highly efficient metasurface based polarization converters are designed. These converters are: linear-to-linear and linear-to-circular. The converters are fabricated and measured to validate simulated reflection coefficients. They are meant for various applications in Ku-, K-, and Ka-bands.

In the fourth and fifth contributory chapters, polarization conversion metasurfaces are employed for RCS reduction of microstrip antennas as well as planar and conformal surfaces over a wideband. The designed structures are well suited to be applied for stealth applications in military systems operating in X-, Ku-, and parts of C- and K – bands.

**Keywords :** Antennas; Bandwidth enhancement; Metamaterials; Metasurfaces; Polarization Converters; Radar Cross Section (RCS); Reconfigurable Antennas; Ultrathin; Unit cell; Wireless Communication Systems.