## Abstract:

In the last decade, wireless communication systems have spread widely and become an essential tool in every days life. A tremendous increase in the demand for small Personal Mobile Devices (PMD) has been observed with wide model ranges and applications. A novel approach is presented to make compact multiband, broadband, ultra wideband (UWB), CP band microstrip patch antennas (MPAs), and array antenna with improved stable radiation patterns at a higher frequency for wire- less communication systems. The challenges with the fabrication and utilization of traditional MPA and array antenna designs at UWB frequency are solved by the method presented here. Also, UWB is rapidly improving as a high-data-rate wire- less communication technology. Like in regular wireless communication systems, an antenna is a very important part of UWB systems. But designing a UWB antenna is harder than designing a narrow-band antenna. A good UWB antenna should be able to work over the Federal Communications Commission's (FCC) ultra-wide bandwidth at the same time, it must have good radiation properties across the entire frequency range.

This thesis focuses on the design and analysis of small multiband, broadband, UWB, and CP band antennas. Broadband and UWB fundamentals and antenna theory have both been the subject of studies. In recent years, the slotted, slit, defected ground structure (DGS), and array patch antenna has been known to be a flexible, low-profile, and cost-effective antenna that can be fine-tuned for UWB operations. The main objective of this thesis is to come up with a practical way to design slotted, slit, and array antennas that works well with the use of full wave analysis methods to show how the design works physically.

A first approach addressed in this thesis work is the application of a technique which includes a double annular ring slot, two L-shaped slots, one I-shaped slot, and a DGS based on an ellipse-shaped slit structure for the purpose of reducing antenna size. Using this methodology one electrically small antenna for triple band for WLAN/WiMAX/C-band downlink satellite communications that can cover almost the entire commercial available frequency bands were developed and their performances are discussed. To reduce the size and enhance the impedance bandwidth (IBW) of the designed antenna using symmetrical staircase-shaped notches, a study is carried out in the next part.

The second part of this thesis work examines the design process for a slotted radiator that will be integrated into a small patch. The main objective of the proposed design structure is to reasonably maintain the radiation properties of the antenna by compacting, enhancing IBW, and controlling the coupling coefficient due to the fraction of the TM01 mode current introduced by the C-shaped slot. As a result, the proposed antenna is shown to have a wider IBW (1.55-16.95 GHz (166.51%)), enhanced gain (2-8.3 dBi), and improved impedance matching. The transmission line model (TLM) of the proposed antenna, which depicts the behavior of the antenna based on the influence of each constituent, is provided. It is noted that the proper- ties of the TLM model closely match with the outcomes of simulations performed using the CST simulator. The prototype is successfully implemented, fabricated, and the results of the experiment are compared with the simulation results. To further reduce the size and enhance the IBW of the designed star-shaped monopole antenna and maintain better gain, a study is carried out in the next work.

The third part of this thesis discusses the compact UWB CPW-fed 9-point star- shaped antenna. A novel concept for efficiently using the reduced space and enhanced IBW (measured IBW 2.2-12.21 GHz) for the proposed antenna is discussed in detail. The functioning theory, design process, simulated, and measured results of the proposed antenna are presented. To study the linear polarization to circular polarization (CP) using traveling wave series-fed circular slits array with DGS and compact structure, a study is carried out which is discussed in the next work.

In the fourth part of this thesis discusses a compact dual-circular polarized traveling waves series-fed circular slit microstrip array (TWSCSMA) antenna. The proposed design gives the left-hand circular polarization (LHCP) wave when the input RF signal for port 1 has a $45^0$ phase increment in clockwise direction. Similarly, the right-hand circular polarization (RHCP) wave is generated, when the input RF signal for port 2 has a $45^0$ phase increment in anticlockwise direction. Using this concept dual-CP radiation can be realized. In this design, due to the two ports formation of the traveling wave series-fed circular slit microstrip array antenna, it gives dual-CP with minimum axial ratio quad-band and two wider IBWs. To further enhance the impedance as well as the axial ratio bandwidth of the proposed monopole CP antenna with extended ground loop plane and compact structure is presented in the final work.

Finally, an inverted L-shaped hook monopole (ILSHM) antenna is designed and fabricated to get UWB impedance and axial ratio bandwidth for CP operational bands. The design process of making CPW-fed two L-shaped conductor strips with two rectangular slits is discussed. By analyzing the simulation and experiment results, it is observed that the proposed antenna shows a compact size, UWB IBW and UWB axial ratio bandwidth, and small bandwidth ratio $BR|_{(10/3)}dB \approx 1.121$. It has demonstrated the essence of the design of a UWB CP antenna for wireless applications.