Micro Electro Mechanical Systems (MEMS) devices demonstrated a wide range of sensing and actuation applications. These mechanical elements present now a days extension to the Radio Frequency (RF) world as key elements for highly reconfigurable systems, frequency references and signal processors. This thesis presents the simulation modeling, design and analysis of RF MEMS switches and Distributed MEMS Transmission Line (DMTL) phase shifters. The work primarily concerns with the reduction of actuation voltage and optimised design of various RF MEMS switches for minimum insertion loss and maximum isolation.

A novel model of calculating spring constant and pull down voltage with critical stress consideration for fixed-fixed beam is reported in this work. This also presents characteristics analysis of RF MEMS capacitive series and shunt switches, lateral switches and micro machined capacitive switches in terms of its S-parameters. For fixed - fixed beam, the stability analysis in beam position due to positive feedback and the solution by adding series capacitance in the DC path of the beam for increasing the stability region is proposed. For the application of implemented work, DMTL with RF MEMS switches optimization is also carried out for maximum phase shift with minimum insertion loss. The static and dynamic characteristics analyses for single and double beam lateral series switches are performed for achieving the optimum circuit parameters with minimum actuation voltage. Optimized micro machined capacitive shunt switch with the reduction of 0.1 µm gap
between the beam and centre conductor for 1.5 V actuation voltage reductions is designed.

Coplanar waveguide (CPW) is an essential transmission line used for signal transmission in RF MEMS switches. This thesis concentrates on the study of parasitic mode effect, probe pad and SMA connector effect of CPW in the calculation of losses for RF MEMS capacitive switch. The different types of structures of CPW have been utilized as the signal path in RF MEMS switch and the optimum capacitive RF MEMS switch with two conductor CPW coupler structure has been proposed with maximum isolation of -40 dB with operating bandwidth upto 90 GHz at its resonant frequency at 50 GHz. All the above mechanical characteristics on the performance of capacitive switches with CPW are simulated using momentum based electromagnetic solver called Advanced Design Systems (ADS) and validated by Artificial Neural Network (ANN).

As this thesis also aims to propose a simple method for the design and analysis of low actuation voltage RF MEMS switches, the silicon armature based capacitive shunt RF MEMS switches which can work with 3.5 V actuation voltage is proposed with ADS simulation and its ANN model is implemented for the validation. The novelty of this thesis is the introduction of neural model for all the above mentioned analyses and optimization related to RF MEMS devices. The problem of large memory requirements and need for high computational efforts in the presently used electromagnetic models have been solved effectively by using neural networks. Based on this work, it is proved that neural network can be used for modelling of RF MEMS devices.
due to their ability to learn the nonlinear relationship between the input and output data.

In this work, the neural network models for the analysis of the following RF MEMS devices are concentrated:

- Spring constant, pull down voltage and residual stress of fixed-fixed beam, by considering the distributed force deflection method.
- Stability analysis of beam position of fixed-fixed beam and proposal of fringing capacitance to increase the stability of fixed-fixed beam.
- Phase shift and isolation loss analysis of DMTL phase shifter.
- Analysis of threshold voltage and loss parameters in single and double beam lateral series switches.
- Determination of critical collapse voltage at which the instability occurs in the beam of micro machined capacitive shunt RF MEMS switch.
- Effects of parasitic mode, probe pad and SMA connector in CPW transmission line for the signal loss in RF MEMS CPW signal path.
- Insertion loss and Isolation analysis of capacitive shunt switch with different CPW configurations.
- Loss analysis of silicon armature based capacitive shunt RF MEMS switch with a calculated minimum actuation voltage of 3.5 V.
Further, in all the above analyses of RF MEMS devices, the neural network model is implemented. The neural network simulated results are compared with the theoretical results using ADS simulation. The neural simulated results agree very well with calculated results in all proposals.

**Keywords:** RF MEMS switch, actuation voltage, loss performance, silicon armature, CPW, Artificial Neural Network, Back Propagation.