Chapter 8

Conclusion

This thesis reports theoretical study of microwave propagation in planar transmission line structures employing ferroelectric and superconducting materials. This work is mainly focused on two types of structures such as multi-layered waveguide structure having homogeneous interfaces and stripline structures having inhomogeneous interfaces. The dispersion relation was constructed in closed form for homogeneous waveguide structures while the spectral domain method was used for the inhomogeneous planar transmission line structures.

The microwave propagation in linear and nonlinear multi-layered waveguide structures with homogeneous interfaces (slab waveguide) were first studied. The strong dependence of permittivity on applied electric field and high tunability is observed. The dispersion relation in nonlinear ferroelectric and superconductor interfaces has been derived in closed form. An increase in propagation constant is observed with increasing the nonlinear parameter for nonlinear structures.

The dispersion characteristics of microstripline, slot line and microstrip resonator structure has been theoretically studied using spectral domain method. First
8.1 Scope of future work

microstrip structures with normal metallization was considered. Tunability and attenuation constant were compared in both strip and slot structures at various electric fields. The dependance of resonant frequency on the length of the strip and thickness of the ferroelectric thin film was also investigated. The variation of resonant frequency with temperature and electric field was studied.

Next, the tunability of the propagation characteristics of superconducting microstrip and slotline waveguide structure supported by ferroelectric thin film was studied. The dependance of propagation characteristics on the operating frequency and temperature for superconducting microstrip and slotlines are investigated. Geometrical parameters like thickness of ferroelectric thin film, width of the slot, and thickness of superconducting strip constituting slot influences propagation characteristics at different biasing electric fields.

Theoretical analysis of electric field tuning characteristics of superconducting coplanar waveguide structure based on ferroelectric thin film has been done using spectral domain method. The propagation constant and attenuation constant shows an increase with operating frequency and thickness of the ferroelectric thin film.

8.1 Scope of future work

The present thesis is an investigation of the wave propagation in multi-layered waveguide structure incorporating ferroelectric and superconducting materials. The analysis employs rigorous full wave methods for accurate characterization of propagation parameters.

Typical applications of the present work are:

1. The results as dispersion in microstrip structure obtained as a function of
external electric field can be used to design tunable phase shifters.

2. The results of resonator structures, when resonance frequency and $Q$ computed as a function of electric field can be directly implemented in tunable filter design.

This study can be immediately extended to a variety of devices and system incorporating these materials. Design of system demands accurate and fast computation of dispersion in a waveguide element, which is provided in the present analysis. The analysis methods can immediately be incorporated in design oriented work, as the codes developed can be included straightaway into a more general computer-aided-design procedure.