ABSTRACT

A new methodology has been evolved by the use of multiple rectangular cavities to model the rectangular waveguide based circuit elements. The methodology involves in replacing all the apertures and discontinuities of the rectangular waveguide based structures, with equivalent magnetic current densities so that the given structure can be analysed using only Magnetic Field Integral Equation (MFIE). To make the MFIE applicable to the generalised waveguide structures problem, the given structure is modeled using rectangular cavities. As it is necessary to use a number of such cavities in order to study these complicated waveguide structures, the present method is named as MULTIPLE CAVITY MODELING TECHNIQUE (MCMT). The interfacing apertures between different regions (waveguide-cavity, cavity-cavity) are then replaced by equivalent magnetic current densities. The magnetic field scattered inside the cavity region due to this source is determined by using the cavity Green's function of the electric vector potential. The cavity Green's function has been derived by solving the Helmholtz equation for the electric vector potential for unit magnetic current source. The scattered magnetic field in the waveguide region due to the presence of the transverse magnetic current densities are solved by rigorous mode matching method. By applying the continuity condition of the tangential magnetic field at the interfacing apertures, and expanding the unknown magnetic current densities in terms of piecewise linear(triangular) basis function by using the Method of Moments, the problem is reduced to solving the simultaneous linear equations.

Using the methodology some of waveguide based structures corresponding to two port and three port networks are studied in this thesis. This includes the two port matching circuits consisting of inductive, capacitive and resonant windows, inductive and capacitive posts which are present in a single are double diaphragm, filters such as resonant iris filters, E plane metal insert filters, and rectangular iris coupled rectangular cavity filters. The three port network includes the simple H plane and E plane T-junctions, iris loaded equal and unequal power divider. The thesis provides a complete and accurate analysis of these problems. Algorithms have been developed for the

determination of the reflection coefficient for the two port network and all the scattering parameters for the three port network. The thesis is broadly divided into following heads:

- **INTRODUCTION** presents an extensive survey of the literature on the different methodologies used for the analysis of different two port, three port and four networks which includes both the waveguide circuit elements as well as waveguide based slot radiators. It also discusses the shortfalls of different methods and the requirement for carrying out the present work.

- **CHAPTER I** presents the derivation of the cavity Green's function for the electric vector potential to be used in solving the Magnetic Field Integral Equations. Different forms of representation and different methodology of deriving the same are discussed.

- The use of Multiple Cavity Modeling Technique is first applied to a simple rectangular piece of waveguide in the **CHAPTER II**. The waveguide piece is modeled with one, two and three cavities and showed that in all the cases excellent results comparable to that of the exact value can be obtained. This work has been done as a confidence building move.

- **CHAPTER III** is devoted to the analysis of waveguide based two port matching circuit elements. After proving application of the present methodology through experimental validation, the chapter carries out the study the characteristics of the different windows and posts and complex diaphragm structures by various parametric variations.

- Analysis of a class of rectangular waveguide based filters is carried out in the **CHAPTER IV** using the Multiple Cavity Modeling Technique. The results from the present theory re compared with the results obtained from the other methods.

- Extensive studies to prove the applicability of the Multiple Cavity Modeling Technique to three port network is carried in the **CHAPTER V**. The simple H plane

and E plane waveguide T-junction is taken up for this purpose and are modeled with two, three and four cavities. The scattering parameters obtained by the use of present methodology are compared with the experimental results.

- **CHAPTER VI** is devoted to the new class of waveguide three port network : the iris loaded equal and unequal waveguide power divider. The present methodology is applied to obtain the scattering parameters of the network and are compared with the results obtained from the other theoretical method as well as from the experimental measurements.

- **CONCLUSION** summarizes the outcome of the thesis. The scope for the future work based on the multiple cavity modeling work is given for extending the utilisation of MCMT.