The work presented in this thesis is carried out by the author to develop a suitable mathematical tool and generate necessary data useful for radiation transport problems associated with high energy accelerators. The data is also expected to find applications in radiation dosimetry for personnel protection and therapeutic purposes. The thesis describes the development of a new method of solving the energy dependent transport equation for charged particles in one dimensional finite systems, and its application to practical problems.

The thesis is divided into four chapters.

CHAPTER I: INTRODUCTION

In this chapter a review of the development of different techniques for solving the transport equation and their application to charged particle transport is described. Since a major part of the earlier work in charged particle transport studies has been carried out using the Monte Carlo method, a brief description of the technique is given along with its limitations. This chapter also gives a critical review of the computational as well as experi-
mental work done in this field. The chapter concludes with the object and the scope of the present work.

CHAPTER II: DEVELOPMENT OF INTEGRAL TRANSPORT EQUATIONS AND ITERATION TECHNIQUE.

In this chapter, a semi-analytical method, to solve the transport equations is developed. The transport equations are cast in the form of coupled integral equations, separating the spatial and energy transmissions. For evaluating the spatial transmission, discrete ordinate representation is used in space, energy and the direction cosine for the particle flux and source. To carry out the collision integral, the source, the flux and the scattering kernel are expanded in Legendre series. The source terms are evaluated for both non-elastic collision and p-p scattering. Unlike other existing methods, no straight-ahead approximation is used in the calculation of the source term due to non-elastic collision. Since each iteration here represents a collision, what is obtained finally is the multicollision source, multicollision flux and multicollision dose, thus simulating the actual physical conditions. The fast convergence of the iteration technique which is the characteristic of the charged particle transport is demonstrated. Angular convergence studies, and convergence studies with spatial mesh points are also carried out.
CHAPTER III: DEPTH-DOSE STUDIES WITH PROTONS.

The method developed in chapter II is used to estimate the depth-dose distributions due to protons incident normally on a 30 cm thick human phantom. The energies of the protons considered, are 140, 150, 200, 300, 400, 600 and 740 MeV. Results obtained are:

1. Secondary proton dose distribution at various depths.
2. Total rad dose at 5 cm depth.
3. Total rad dose at the surface.
4. The above values for the secondary protons.
5. The rad doses are calculated at various energy intervals over which the quality factor (Q.F.) is constant. This method of calculation will enable incorporating changes in the values of the quality factor as and when required without effecting major changes in the program. From these, the following results are obtained:

1. Total average rem dose and the average Q.F.
2. Total rem dose and the average Q.F. at 5 cm depth.
3. Total rem dose and the average Q.F. at the surface.
4. These values for the secondary protons.

A least square analysis is carried out to represent the current to rem dose in an analytical form.
The results obtained by the present method are compared with those by Monte Carlo calculations and also with the experimental values. The agreement is quite good. Further, the results are free from statistical errors as is the case with the Monte Carlo results.

CHAPTER IV: PION TRANSPORT STUDIES.

This chapter describes the application of the transport method, developed in chapter II, to study the transport of pions produced due to interaction of protons of energy greater than 400 MeV, with human tissue. The convergence with iteration in this case is quite fast and in fact is better than that in the case of protons. Pion depth dose distributions are calculated for 600 and 1000 MeV protons incident normally on a 30 cm thick human phantom and the results are compared with the Monte Carlo values. The deviations between the two results are explained in terms of uncertainty associated with the input data for the differential angular distribution of the secondary pions.