

PREFACE

Fractional integro-differential equations (FIDE) are integro-differential equations in which we deal with the derivative and integration of non-integer order of a function. The origin of FIDEs may be traced from the work of Abel, Fredholm, Volterra, Mathus, Verholst in mechanics, mathematical biology, economics etc. The use of fractional differentiation and integration becomes important due to fact that it provides a more accurate model of the system under consideration as the classical order derivatives fail to do. Over the past few decades, FIDEs reflected in a large number of research papers and books covering some of these areas.

The applications of the fractional order derivatives and integration were seen around 19th century. But its origin was considered around the 17th century by L'Hôpital. Nowadays fractional calculus (FC) has a wide range of applications in different fields like study of several natural and real-world problems such as frequency-dependent-damping problems arise in viscoelastic materials [3], continuum and statistical mechanics [4], and dynamics of interfaces between nanoparticles and substrates [5]. Fractional derivatives and integration which mostly used in this thesis are defined using Riemann Liouville and Caputo derivatives. Recently, the generalization of Riemann- Liouville and Caputo derivatives are presented in [6, 30] and its few applications were discussed. In this thesis, we have derived a generalized method to find the solution of FIDEs in terms of the B operator. In general, finding the solution to FIDEs is more complex as it contains both derivative and integration of functions. Here, an attempt is made to solve FIDEs defined in terms of the B -operator using collocation method approach in Chapter 2. Further, the collocation approach is extended for two dimensional generalized fractional partial integro-differential equation in Chapter 3.

Chapter 4 and 5 are based on solving fractional diffusion equations. Fractional diffusion equations are used to study the anomalous behavior of diffusion equations which is derived from Fick's second law. Anomalous behavior is the classification of the diffusion process when there is no linear relationship between the mean square displacement (MSD) with time. In Chapter 4, we study fractional diffusion equations where derivatives on the time variable are defined in the Caputo sense and diffusion terms on space variables are taken as classical derivatives. Further, we apply the finite difference method to the time variable and the collocation approach to space variables. In this way, we get a fully discretized scheme of the considered problem and further we use it for the numerical approximations. Chapter 5 deals with the fractional advection diffusion equation (FADE) in three variables. FADE given in Chapter 5, is the extension of the problem defined in Chapter 4. Finally the collocation method is studied for solving the FADE in one and two dimensions.