

PREFACE

During the second half of the twentieth century, considerable amount of research in fractional calculus was published in engineering literature. The recent advances of fractional calculus are dominated by modern examples of applications in differential and integral equations, physics, signal processing, fluid mechanics, viscoelasticity, mathematical biology, and electrochemistry. There is no doubt that fractional calculus has become an exciting new mathematical method of solution for diverse problems in mathematics, science, and engineering.

In view of the above I took up the study entitled “A STUDY OF FRACTIONAL INTEGRAL DIFFERENTIAL OPERATORS WITH THEIR APPLICATION TO DIFFUSION PROBLEM”. This study is carried out by me at School of Mathematics and Allied Sciences, Jiwaji University, Gwalior.

The first chapter is devoted to the general introduction of the subject. Besides including a historical to the state of the art review of the developments in the subject, this chapter throws light on the topics such as integral and differential operators, different fractional calculus functions, integral transforms and fractional diffusion equation.

In the second chapter we have established the relationship of Saxena’s I-function with various fractional calculus operators including
Reimann-Liouville operator, Erdelyi-Kober operator and Saigo operators. The results are mostly derived in a closed form in terms of I-function.

In the third chapter, we have obtained a new result involving recently defined, generalized hyper geometric function named as Aleph function and its relation with fractional calculus operators with the help of Laplace transform.

In the fourth chapter, we derive the solution of fractional diffusion equations involving Weyl and Saigo-Maeda operators employing Laplace and Fourier transforms. Their respective solutions are given in terms of Mittag-Leffler function and its generalization, which can also be represented as Fox’s H-function. The results proved in this chapter can find application to a wide range of engineering, astrophysics and physical science.

In the fifth chapter, we have presented the solution of fractional reaction-diffusion equations with the help of Mellin and Fourier transform. The solution has been obtained in terms of Saxena’s I-function in a compact and elegant form.

In the sixth chapter, we present the solution of a delay fractional kinetic equation with the help of Mellin transform. In addition the solution of a delay fractional kinetic equation involving generalized Lauricella function has been obtained. The techniques used in this chapter can be
applied to similar equations arising in astro-physics, engineering, chemical and physical sciences.

*In the seventh chapter,* deals with the investigation of the solution of the non-homogeneous space-time fractional telegraph equation associated with the Riemann-Liouville fractional derivative as the time derivative and the Riesz-Feller derivative as the space derivative by using Laplace and Fourier integral transforms.

*In the eighth chapter,* of the thesis, we have demonstrated the use of Sumudu and Fourier transforms for the solution of fractional telegraph equations with positive real parameters. The solutions have been expressed in terms of Mittag-Leffler function and generalized Mittag-Leffler functions.

Finally, an exhaustive list of *References* used in the thesis has been appended.

*(Satendra Kumar Tripathi)*