

**Fractional Calculus:** Study of basic functions – Gamma function, Mittag-Leffler function, Hypergeometric function, fractional calculus a generalization of integer order calculus.

**Fractional derivatives and Integrals:** Definition of fractional derivatives and integrals- Riemann-Liouville, Caputo and Grunwald-Letnikov, and their relations, properties of fractional derivatives, computation of fractional derivatives for some basic functions like constant, exponential, log, sine, cosine, Laplace transform of Riemann-Liouville, Caputo and Grunwald-Letnikov derivatives.

**Properties of Differintegration :** Linearity, differintegration term by term, homogeneity, scale change Leibniz's rule, chain rule.

**Differintegration of simple functions:** Differintegrable functions-unit function, zero function, function of  $(x-a)$ , function  $(x-a)^p$ , Binomial function, exponential functions, Heaviside and Dirac functions.

**Fractional Differential Equation (FDE):** Solving homogeneous FDEs- direct approach, Laplace transform approach, linear independent solutions, solving fractional integral equations, short memory principle, law of irreversibility nonlocality.

**Applications of Fractional Calculus:** Able's fractional integral equation- the Tautochrone problem, fractional damped motion, semi-infinite line in circuits -semi-differentiator circuit.

**TEXT BOOKS/ REFERENCES:**

1. Shantanu Das, "*Functional Fractional Calculus*", Springer-Verlag Berlin Heidelberg, 2011.
2. I. Podlubny, "*Fractional Differential Equations*", Academic Press, USA, 1999.
3. K. S. Miller and B. Ross, "*An Introduction to the Fractional Calculus and Fractional Differential Equations*", John Wiley & Sons, USA, 1993.
4. K. B. Oldham and J. Spanier, "*The Fractional Calculus*", Dover Publications, USA, 2006.