## Abstract of thesis

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**Thesis title: On Continuous Fractional Calculus and its Application to Epidemic Models**
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In this thesis, we have studied the analysis of seven different epidemic models under various conditions. In Chapters 2 – 6, epidemic models of some infectious diseases (COVID-19, Dengue) are analyzed and in Chapter 7 – 8, general epidemic models are studied. In the beginning, the dynamics of COVID-19 transmission is described, using a fractional order $SIQR$ model. To obtain semi-analytic solutions to the model, the Iterative Laplace Transform Method [ILTM] is implemented. Considering COVID-19 cases data in India and Brazil, collected upto 1st August, 2020, the basic reproduction number $R_0$ is estimated to be 1.7824 and 2.767 respectively. In Chapter 3, a fractional order $SEIR$ model with vaccination has been studied. It has been found that introduction of the vaccination parameter $\eta$ reduces the reproduction number $R_0$. Based on the COVID-19 cases data in India, collected upto 1st August, 2021, the basic reproduction number $R_0$ without vaccinations estimated to be 3.67 and with vaccination to be 1.55. As is evident from this study that vaccination is an effective method in control and prevention of the COVID-19 disease. Chapter 4 presents a study of an $SEIRV$ epidemic model with optimal control in the context of Caputo fractional derivative of order $0 < \alpha \leq 1$. A comparative study of the model values and real scenario of Brazil starting from 10th April 2021 through 100 days has been performed. It has been observed that the model fits with $\alpha = 0.85$ with realistic data. In Chapter 5, the fractional order $SEIQRD$ compartmental model of COVID-19 is explored with six different categories in the Caputo approach. From 1st of January 2022 to 31st of January 2022, we have compared model values with real data in Italy. This study looked at the many consequences of wearing face masks, and it was discovered that wearing face masks consistently can help reduce the propagation of COVID-19 disease. In Chapter 6, a four compartment host population and a three compartment vector population is considered in a fractional order dengue model in the Caputo sense with a consideration of three control parameters. Two of the control parameters are related to the host population and one is related to the vector population. The fractional order $SIR$ model with a Holling type II saturated incidence rate and treatment rate are explored in Chapter 7 in the Caputo order fractional derivative approach. For $R_0 = 1$ at $E_0$ the model exhibits a forward bifurcation. In Chapter 8, we analyze a fractional order $SIR$ mathematical model with nonlinear incidence rate of infection as Holling type II and the treatment rate is considered as Monod-Haldane (MH) type. The existence and uniqueness criteria as well as the non-negativity and boundedness have been established. The model's fundamental reproduction number $(R_0)$ was also calculated using the next generation matrix technique. The stability of all proposed model systems at all equilibrium points are demonstrated. The sensitivity analysis, which allows the determination of key parameters in the proposed different models have been carried out. Different numerical methods like Adam-Bashforth-Moulton predictor-corrector, Euler and Taylor's are utilized to approximate the solution to fractional order proposed models. Graphical demonstrations and numerical simulations have been presented using MATLAB. Modeling using fractional-order derivatives is often more efficient than modeling with integer-order derivatives because the option of derivative order gives one more degree of freedom, resulting in a better fit to real-time data with less inaccuracy than the integer-order model.

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