Assignment 01
Differential Equations Fall 2023
BS-V (CS) Sections B,C,D,E
Course Supervisor Adnan Rauf

**Solve nonlinear Lorenz Model in Google Collaboratory**

See the following page for details

Note:

(1) Submit your Assignment as a PDF File with a live link for Google Collaboratory Jupyter Notebook

(2) Graph of the solution should include a time series plot for each variable x y and z

(3) A 3D phase portrait plot of x y z variables.

(4) Elaborate the phenomena of sensitive dependence on initial conditions exhibited by the Lorenz Model

(5) What is Butterfly Effect

A legendary model is that of meteorologist Edward N. Lorenz (1917–2008), who brought significant insights to the theory of **deterministic chaos**. It is described by the following system of nonlinear differential equations:

$$\left.\begin{array}{rl} \dot{x} = & a(y-x) \\ \dot{y} = & x(b-z) - y \\ \dot{z} = & xy - cz \end{array}\right\} .$$
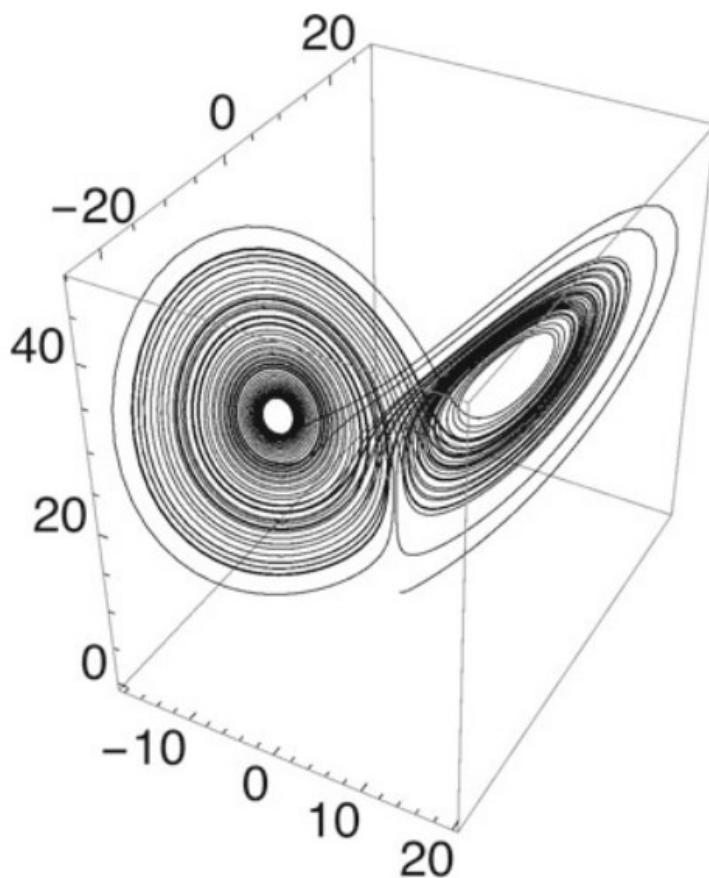
The figure[5] shows the associated graph of the numerical solution for parameter values $a = 10$, $b = 28$, $c = 8/3$ with initial values $(x(0), y(0), z(0)) = (0, 1, 0)$.

Using his model, Lorenz discovered that very small changes in the initial conditions can eventually evolve into considerably different solutions. This explains why precise long-range weather forecasting is impossible. But he also found that the solutions all are confined to a narrow region of space, hence a certain structure is maintained. More on this can be found in [1]. ◇