

AFRICAN INSTITUTE FOR MATHEMATICAL SCIENCES  
(AIMS RWANDA, KIGALI)

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Name: Yusuf Brima  
Course: Fluid Mechanics

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## Exercise 1

- (i) Given the dynamical systems in (1), the 4<sup>th</sup> order Runge-Kutta solution is plotted below.

$$\frac{d\mathbf{x}}{dt} = \begin{pmatrix} 5 & 1 \\ 3 & 1 \end{pmatrix} \mathbf{x} \quad (1)$$

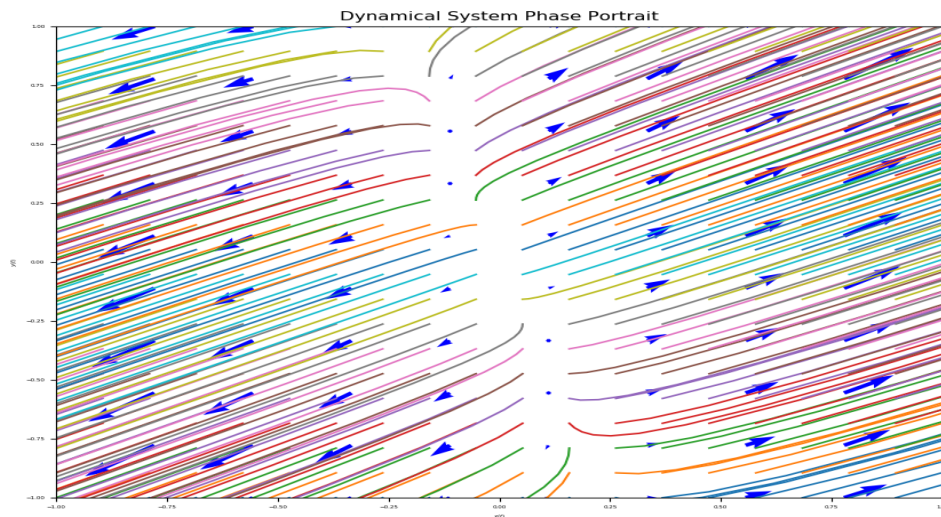


Figure 1: A plot of the dynamical system of ODEs using RK4 method

- (ii) Given the dynamical systems in (2), the 4<sup>th</sup> order Runge-Kutta solution is plotted below.

$$\frac{d\mathbf{x}}{dt} = \begin{pmatrix} 2 & -5 \\ 1 & -2 \end{pmatrix} \mathbf{x} \quad (2)$$

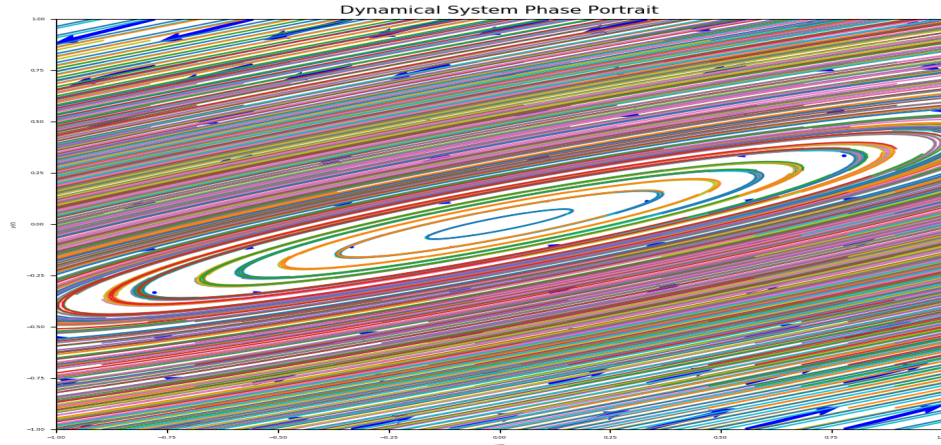


Figure 2: A plot of the dynamical system of ODEs using RK4 method

(iii) Given the dynamical systems in (3), the 4<sup>th</sup> order Runge-Kutta solution is plotted below.

$$\frac{d\mathbf{x}}{dt} = \begin{pmatrix} 1 & -5 \\ 1 & -3 \end{pmatrix} \mathbf{x} \quad (3)$$

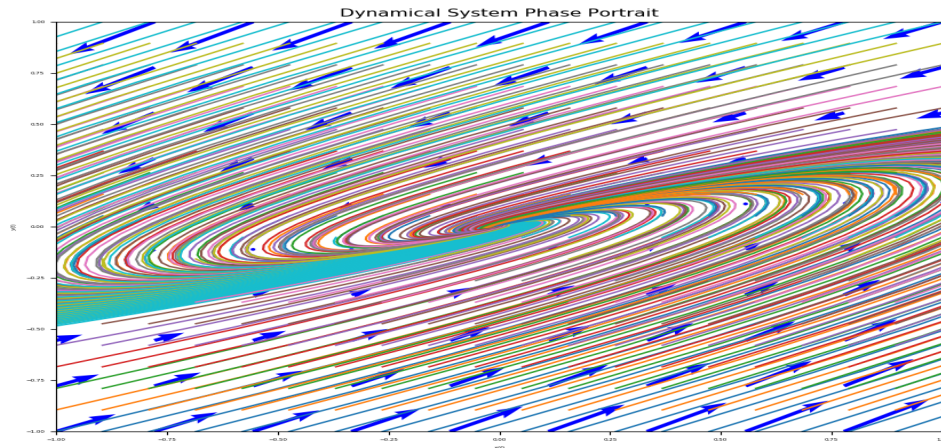


Figure 3: A plot of the dynamical system of ODEs using RK4 method

(iv) Given the dynamical systems in (4), the 4<sup>th</sup> order Runge-Kutta solution is plotted below.

$$\frac{d\mathbf{x}}{dt} = \begin{pmatrix} 2 & -1 \\ 3 & -2 \end{pmatrix} \mathbf{x} \quad (4)$$

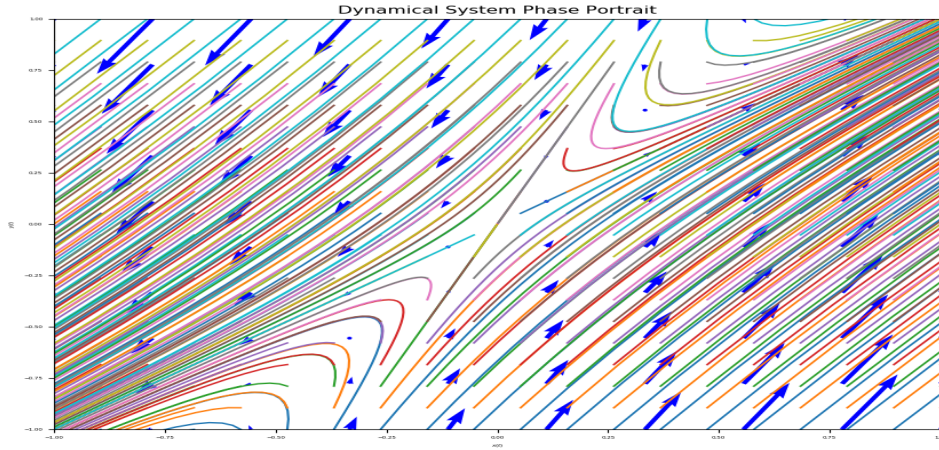


Figure 4: A plot of the dynamical system of ODEs using RK4 method

## Exercise 2

Given

$$\frac{dx}{dt} = y - x^2, \quad \frac{dy}{dt} = x - 2 \quad (5)$$

- (i) We calculate the equilibrium point as thus:
- (ii) We proceed as follows to linearize the dynamical system around the equilibrium in (5).
- (iii) We find the eigenvalue and eigenvector of the linearized system, and the character of the equilibrium.
- (iv) Given the dynamical systems above the 4<sup>th</sup> order Runge-Kutta solution is plotted below.

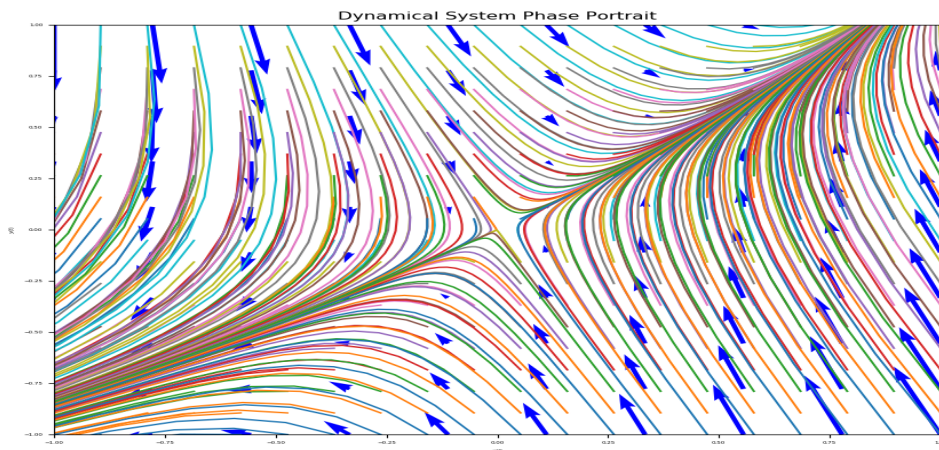


Figure 5: A plot of the dynamical system of ODEs using RK4 method