1 Questions
Let us consider the following well-known system of equations

$$\begin{aligned} \frac{dx}{dt} &= \sigma(y-x), \\ \frac{dy}{dt}+y &= rx - xz, \\ \frac{dz}{dt} &= xy - bz, \end{aligned}$$

1. Use MATLAB ODE function ode45 to solve (A1) for t $\in$ [0; 10] usingσ = 10, r = 28
and b=8/3 and the initial conditions

$$[x, y, z]_{t=0} = [-2, -3.5, 21]$$

2. Plot the solution y(t) using a green dashed line. Add the suitable labels to the axes.
3. To see the effect of changing the initial values, solve the ODE system using the initial
values shown above but change x(0) to -2, 04. Plot y(t) in the SAME figure used in (2) .
4. Explain the results shown in the previous figure.
5. Use the ODE solver ode23 to solve the ODE system with the initial values given in
(3). Save the values of t in a vector T1 and the values of x in a vector X1.
6. Find the maximum absolute error and the maximum relative error between the two
solutions you obtained in (3) and (5)?
7. Use the ODE solver ode23s to solve the ODE system with the initial values given in
(3). Save the values of t in a vector T2 and the values of x in a vector X2.
8. Plot the solution you just obtained in the SAME figure with the solutions obtained
using ode45 in (1) and ode23 in (5).
9. What do you notice from the previous figure?
10. Solve the problem again using ode23s using the following values of RelTol : 10^{-4}; 10^{-5}; 10^{-6}
and 3$\times$ 10^{-7} . with the initial values given in (3). Plot All the solutions in one figure.
11. What do you notice from the previous plot?
12. Use the suitable function in MATLAB to find the equilibrium points (steady-state
points) of the system (A1) for the following values of the parameters σ = 10, b = 8/3
and

(a) r = 28.
(b) r = 1.
(c) r = 0:5.

For each case, write the code and show the results. What do you conclude from you results?