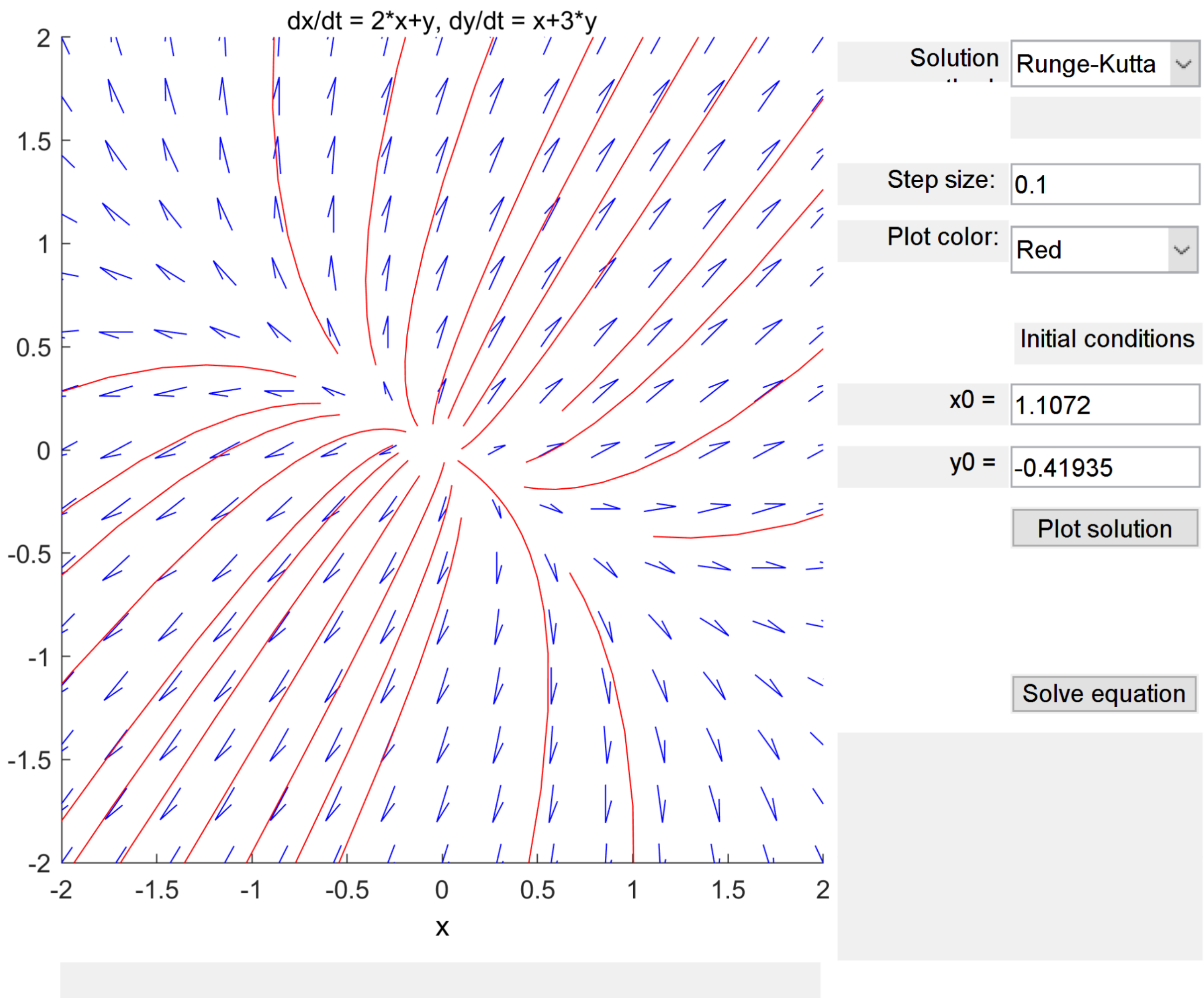
1. **dx/dt = [2 1; 1 3] x**

   a. **Phase Portrait**



   b. **Equilibrium:**

      - **Asymptotic stability:** Unstable
      - **Behaviour:** Nodal source
      - **Clockwise/Counterclockwise:** N/A

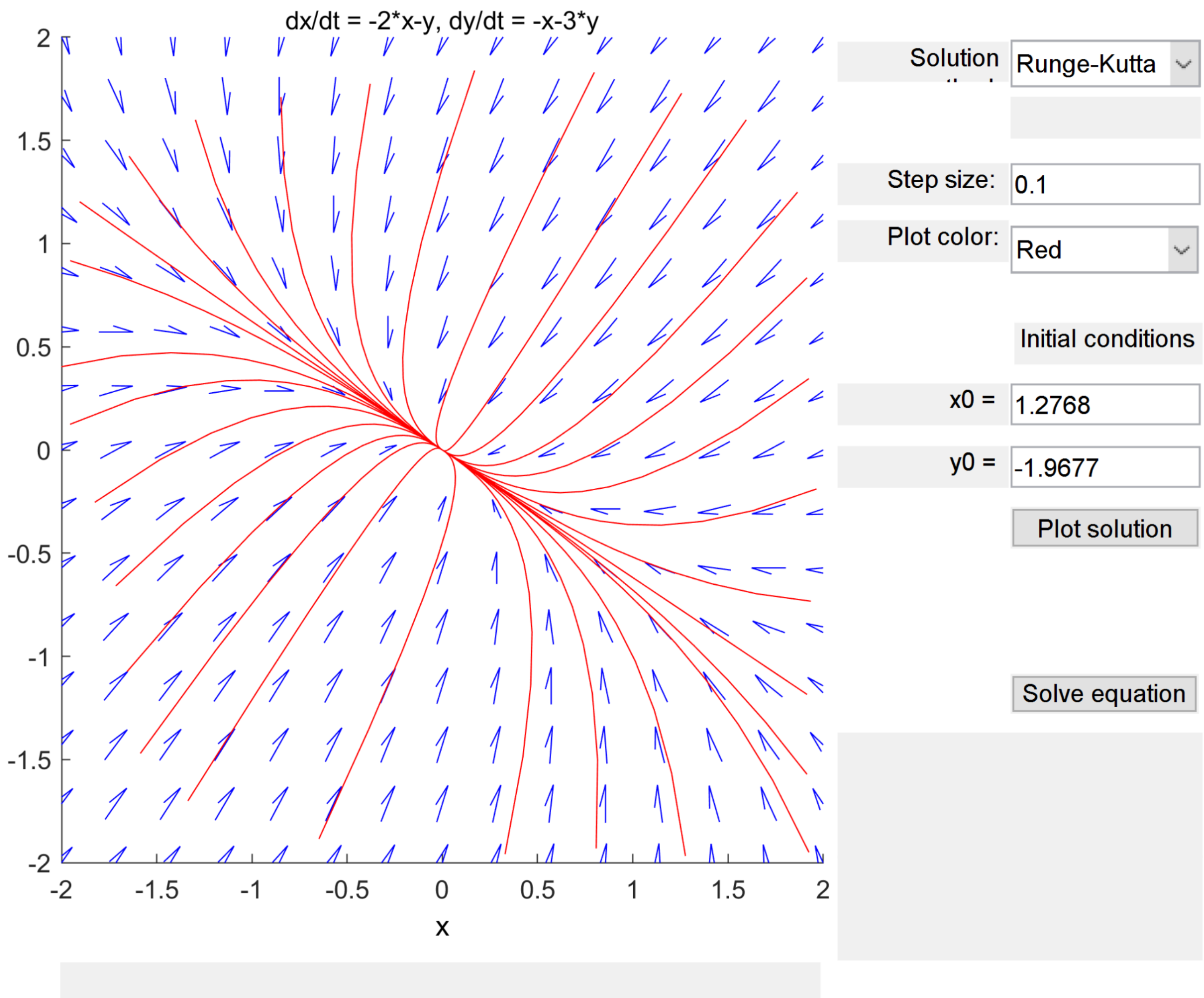
   c. **Eigenvalues:**

      i. $\lambda_1 = \frac{5+\sqrt{5}}{2}, \lambda_2 = \frac{5-\sqrt{5}}{2}$

      ii. **Justification:** The eigenvalues for the system are real, positive, and distinct. Therefore (0,0) is an unstable nodal source.

2. dx/dt = [-2 -1; -1 -3] x

a. Phase Portrait



b. Equilibrium:

- **Asymptotic stability:** Asymptotically stable
- **Behaviour:** Nodal sink
- **Clockwise/Counterclockwise:** N/A

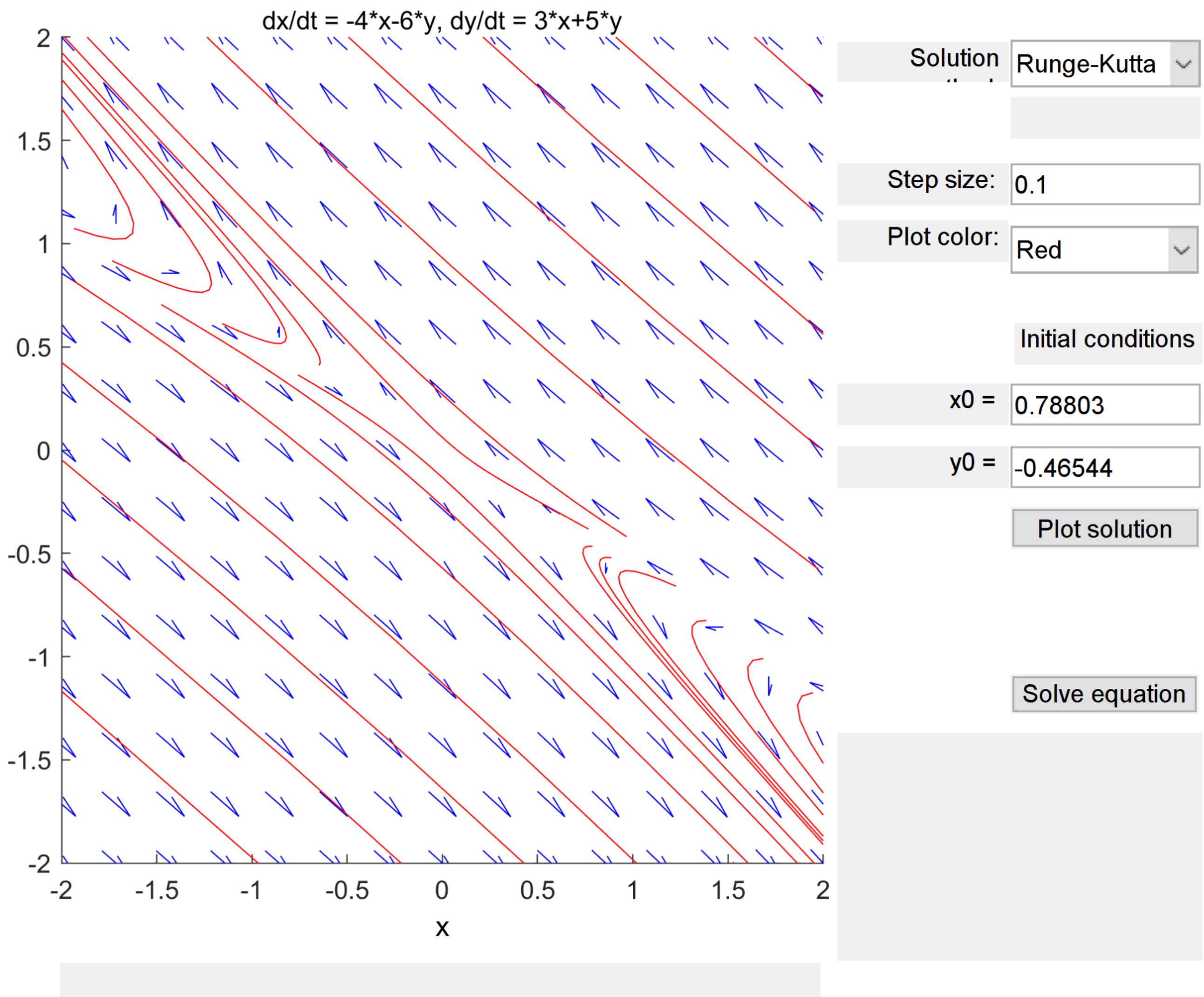
c. Eigenvalues:

i. $\lambda_1 = \frac{-5+\sqrt{5}}{2}, \lambda_2 = \frac{-5-\sqrt{5}}{2}$

ii. **Justification:** The eigenvalues for the system are real, negative, and distinct. Therefore (0,0) is an asymptotically stable nodal sink.

3. dx/dt = [-4 -6; 3 5] x

a. Phase Portrait



b. Equilibrium:

- **Asymptotic stability:** Unstable
- **Behaviour:** Saddle
- **Clockwise/Counterclockwise:** N/A

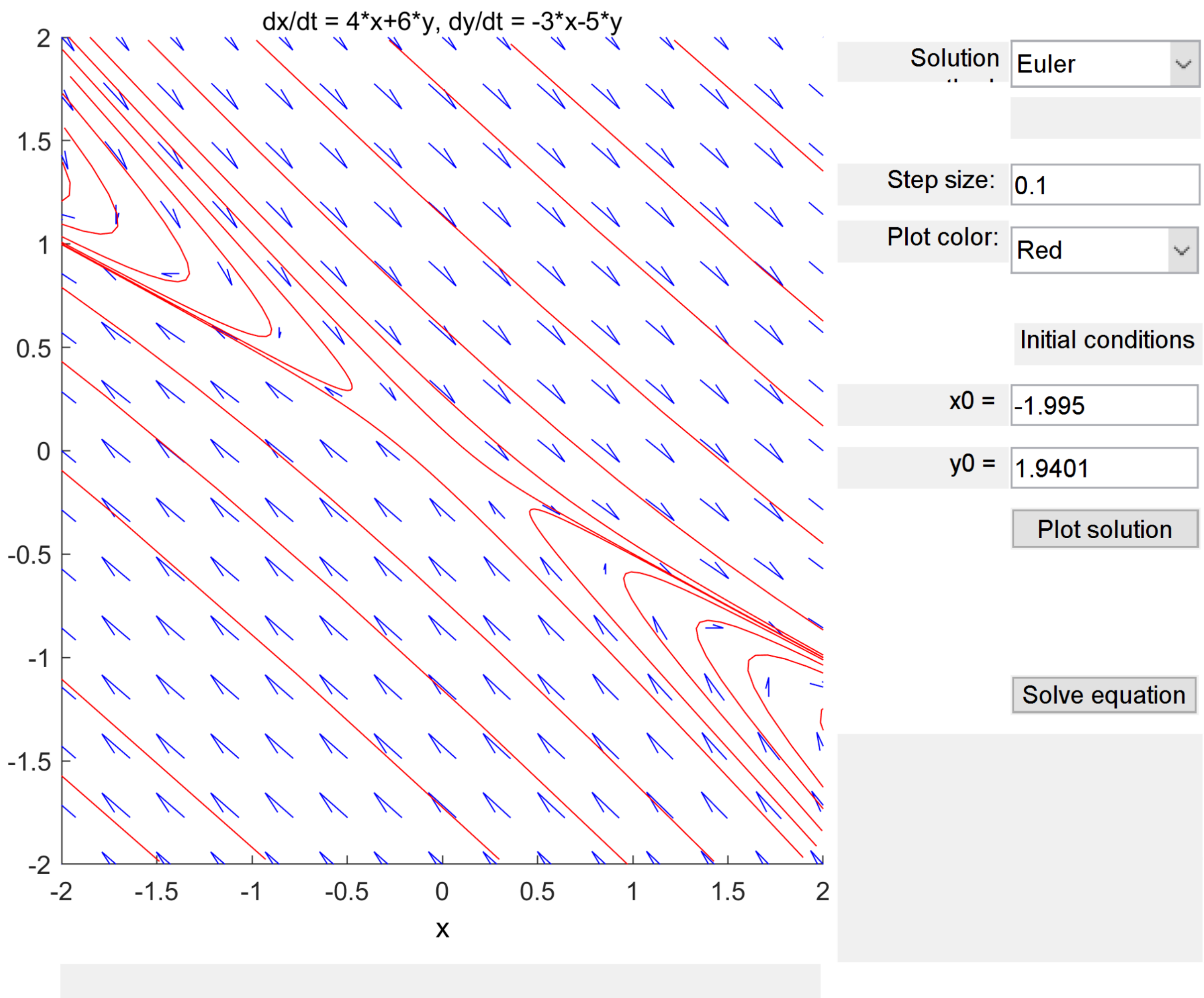
c. Eigenvalues:

i. $\lambda_1 = 2, \lambda_2 = -1$

ii. **Justification:** The eigenvalues for the system are real and distinct, and have opposite signs. Therefore (0,0) is an unstable saddle point.

4. dx/dt = [4 6; -3 -5] x

a. Phase Portrait



b. Equilibrium:

- **Asymptotic stability:** Unstable
- **Behaviour:** Saddle
- **Clockwise/Counterclockwise:** N/A

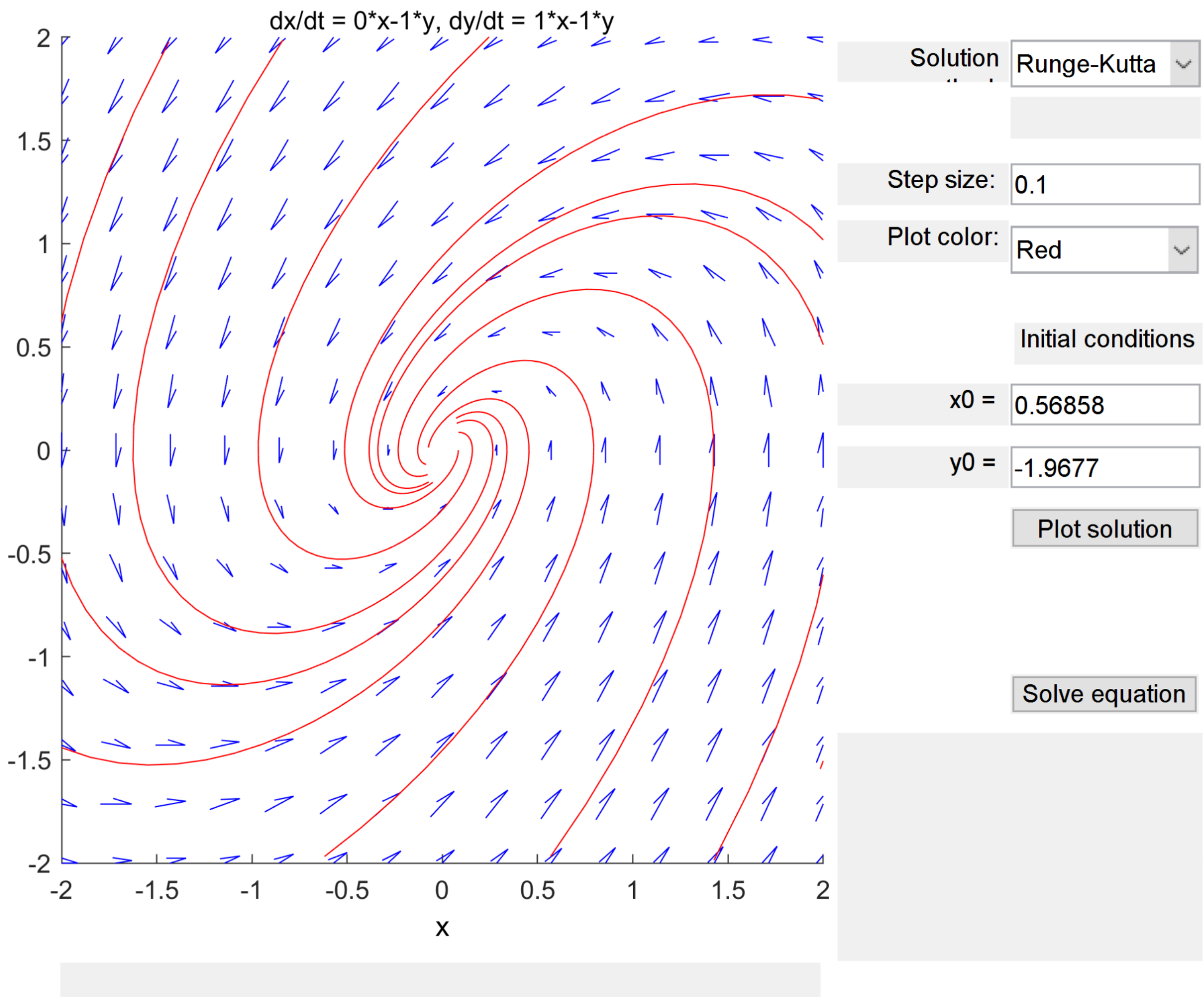
c. Eigenvalues:

i. $\lambda_1 = -2,\ \lambda_2 = 1$

ii. **Justification:** The eigenvalues for the system are real and distinct, and have opposite signs. Therefore (0,0) is an unstable saddle point.

5. **dx/dt = [0 -1; 1 -1] x**

   a. **Phase Portrait**



   b. **Equilibrium:**

      - **Asymptotic stability:** Asymptotically stable
      - **Behaviour:** Spiral sink
      - **Clockwise/Counterclockwise:** Counter-clockwise

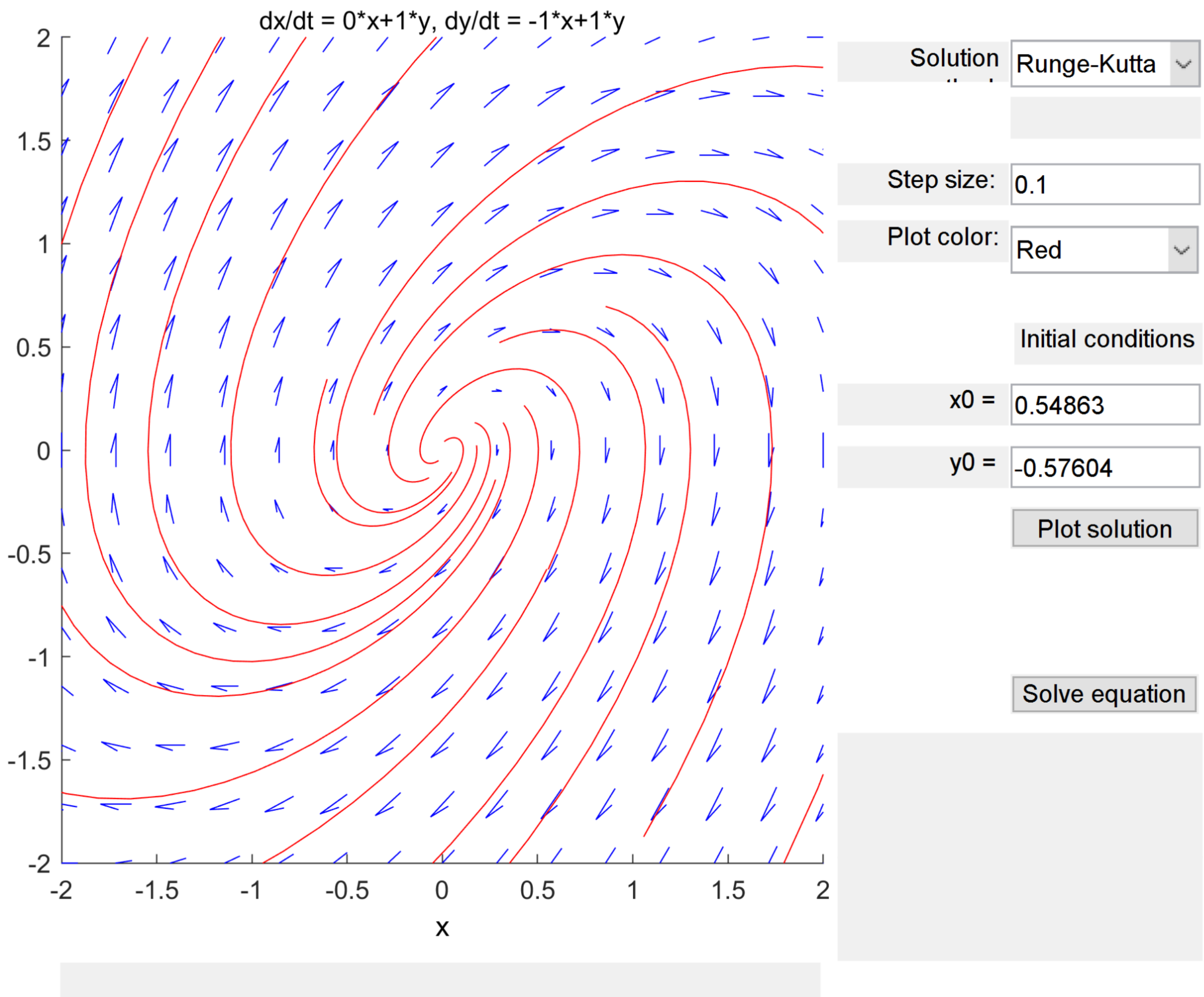
   c. **Eigenvalues:**

      i. $\lambda_1 = \frac{-1+i\sqrt{3}}{2},\ \lambda_2 = \frac{-1-i\sqrt{3}}{2}$

      ii. **Justification:** Both eigenvalues are complex, and the real components of the eigenvalues are less than zero. Therefore (0,0) is a stable spiral sink.

6. dx/dt = [0 1; -1 1] x

a. Phase Portrait



b. Equilibrium:

- **Asymptotic stability:** Unstable
- **Behaviour:** Spiral source
- **Clockwise/Counterclockwise:** Clockwise

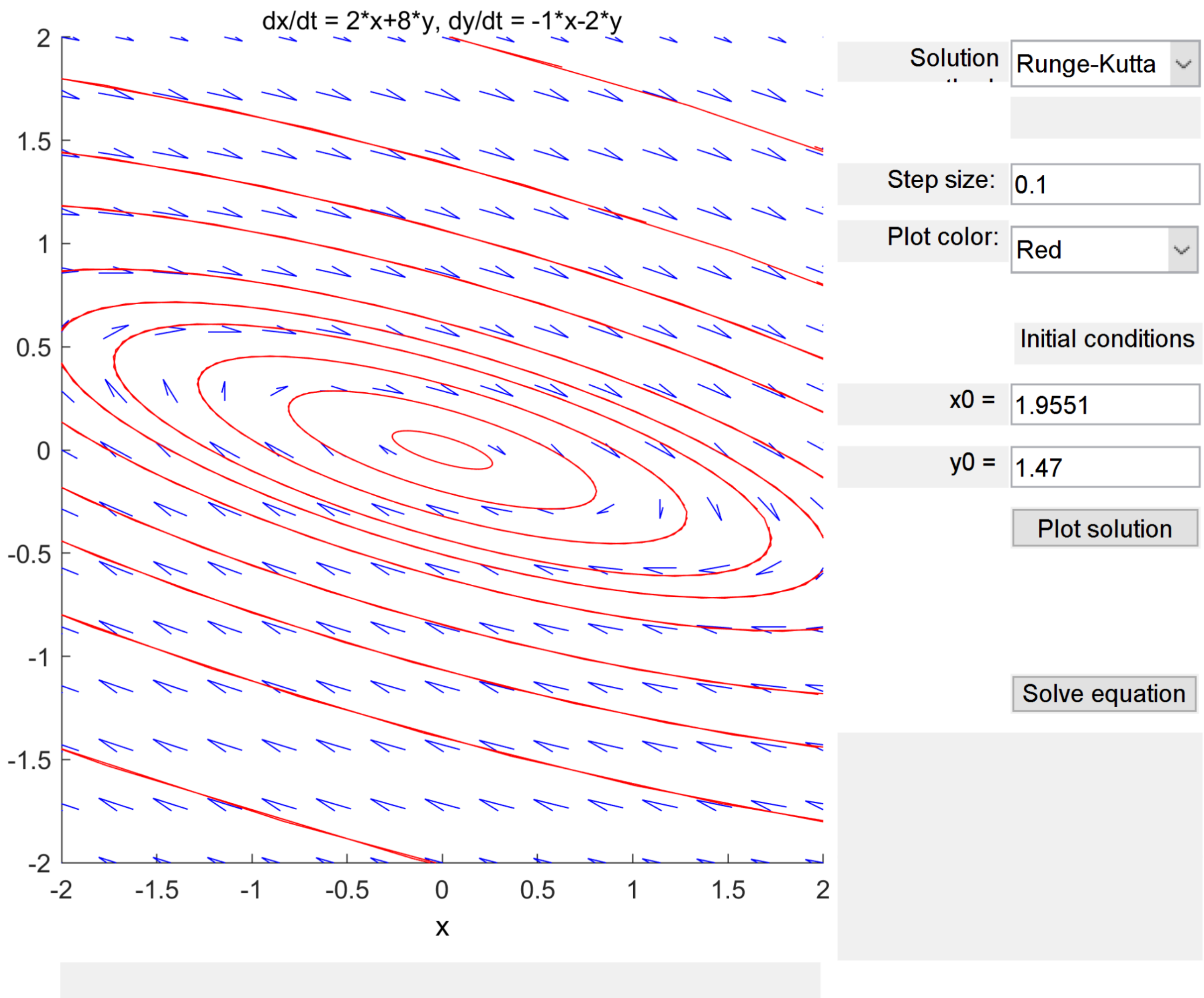
c. Eigenvalues:

i. $\lambda_1 = \frac{1+i\sqrt{3}}{2}$, $\lambda_2 = \frac{1-i\sqrt{3}}{2}$

ii. **Justification:** Both eigenvalues are complex, and the real components of the eigenvalues are greater than zero. Therefore (0,0) is an unstable spiral source.

7. dx/dt = [2 8; -1 -2] x

a. Phase Portrait



b. Equilibrium:

- **Asymptotic stability:** Stable
- **Behaviour:** Center
- **Clockwise/Counterclockwise:** Clockwise

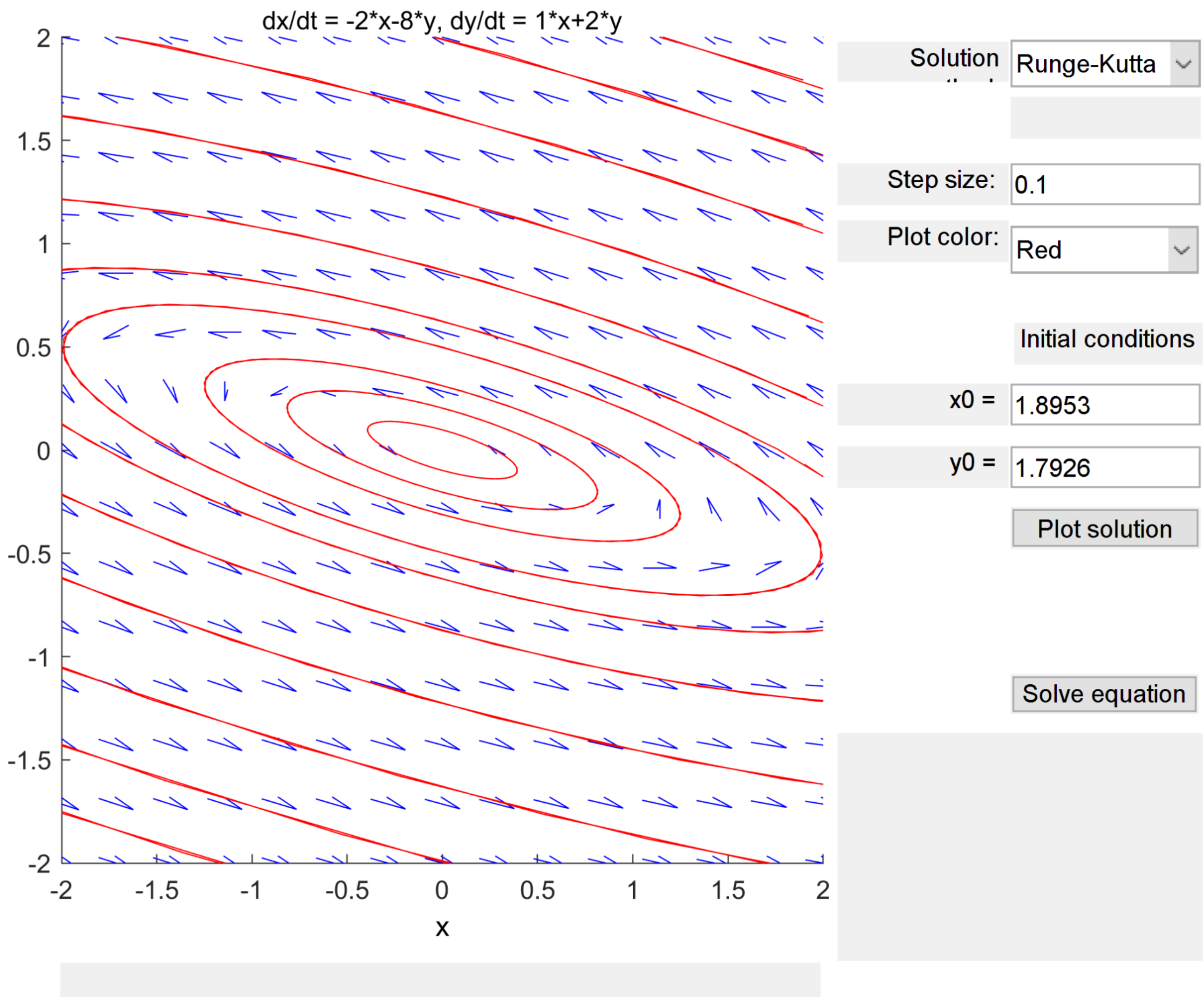
c. Eigenvalues:

i. $\lambda_1 = 2i,\ \lambda_2 = -\ 2i$

ii. **Justification:** The real components of the eigenvalues are equal to zero (eigenvalues are imaginary). Therefore (0,0) is a stable center.

8. dx/dt = [-2 -8; 1 2] x

a. Phase Portrait



b. Equilibrium:

- **Asymptotic stability:** Stable
- **Behaviour:** Center
- **Clockwise/Counterclockwise:** Counter-clockwise

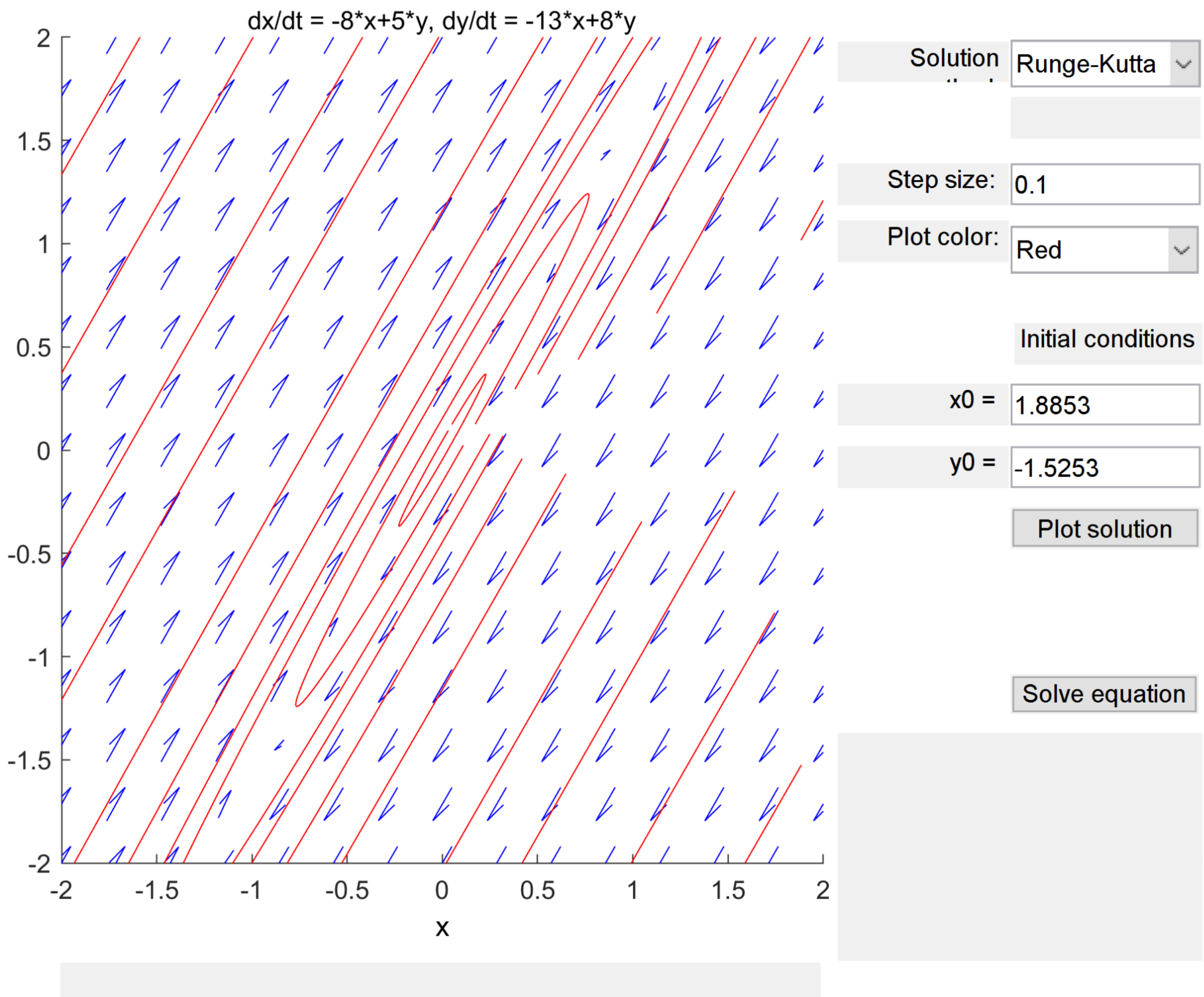
c. Eigenvalues:

i. $\lambda_1 = 2i, \lambda_2 = -2i$

ii. **Justification:** The real components of the eigenvalues are equal to zero (eigenvalues are imaginary). Therefore (0,0) is a stable center.

9. dx/dt = [-8 5; -13 8] x

a. Phase Portrait



b. Equilibrium:

- **Asymptotic stability:** Stable
- **Behaviour:** Center
- **Clockwise/Counterclockwise:** Clockwise

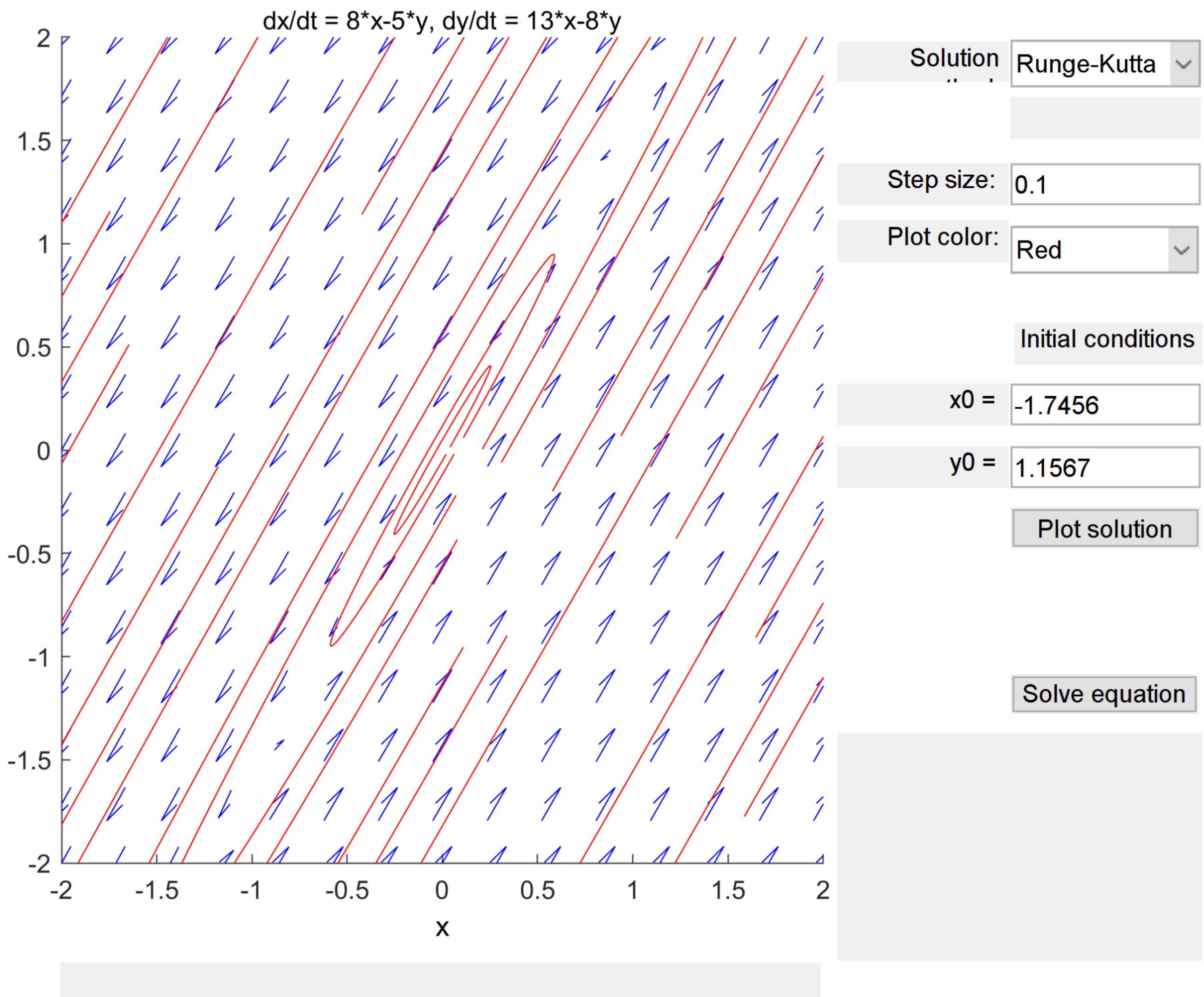
c. Eigenvalues:

i. $\lambda_1 = i, \lambda_2 = -i$

ii. **Justification:** The real components of the eigenvalues are equal to zero (eigenvalues are imaginary). Therefore (0,0) is a stable center.

10. dx/dt = [8 -5; 13 -8] x

a. Phase Portrait



b. Equilibrium:

- **Asymptotic stability:** Stable
- **Behaviour:** Center
- **Clockwise/Counterclockwise:** Counter-clockwise

c. Eigenvalues:

i. $\lambda_1 = i, \lambda_2 = - i$

ii. **Justification:** The real components of the eigenvalues are equal to zero (eigenvalues are imaginary). Therefore (0,0) is a stable center.