**Practice Questions**

1. Solve the initial value problem

$$\begin{cases} y''(t) + y(t) = f(t), \\ y(0) = 0, \ y'(0) = 1, \end{cases}$$

where

$$f(t) = \begin{cases} t & \text{if } t \in [0, 1), \\ 1 & \text{if } t \in [1, \infty). \end{cases}$$

2. Find the general real-valued solution to the system

$$\vec{\mathbf{x}}'(t) = \begin{bmatrix} 3 & -5 \\ 2 & 5 \end{bmatrix} \vec{\mathbf{x}}(t).$$

3. Find the general solution of the system

$$\begin{cases} x'(t) = x(t) + 4y(t) + 4z(t), \\ y'(t) = 3y(t) + 2z(t), \\ z'(t) = 2y(t) + 3z(t). \end{cases}$$

4. Consider the nonlinear system of ordinary differential equations given by

$$\begin{aligned} x'(t) &= x(t) + y(t)^2, \\ y'(t) &= x(t) + 2y(t). \end{aligned}$$