PROBLEM 1 - SOLUTION

The discretization of the system dynamics matrix can be achieved by approximating the continuous derivative of x to a discrete difference equation as follows:

$$\dot{x}(t) \approx \frac{x[k+1] - x[k]}{dt} \tag{1}$$

where dt is the time interval between two subsequent samples.

Given the linear system in the question, one can describe it as:

$$\dot{x}_1(t) = x_2(t) \tag{2}$$

$$\dot{x}_2(t) = 0$$

Using the approximation given by (1) into (2), yields:

$$x_1[k+1] = x_1[k] + dt * x_2[k] \tag{3}$$

$$x_2[k+1] = x_2[k]$$

Finally, the system of equations represented by (3) can be represented in a matrix form as follows:

$$X[k+1] = \begin{bmatrix} 1 & dt \\ 0 & 1 \end{bmatrix} X[k] \tag{4}$$