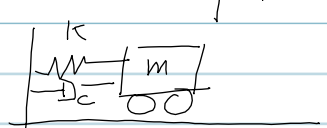


SDoF $\rightarrow u$

$$\underbrace{m\ddot{u} + c\dot{u} + ku = p(t)}_{\text{2nd Order}} \leftarrow$$


$$Ax + Bp = \dot{x}$$
$$Cx + Dp = y \leftarrow \text{outputs}$$

states \swarrow \nwarrow Inputs

where

$$x = \begin{Bmatrix} u \\ \dot{u} \end{Bmatrix}$$

$$\begin{bmatrix} 0 & 1 \\ -\frac{k}{m} & -\frac{c}{m} \end{bmatrix} \begin{Bmatrix} u \\ \dot{u} \end{Bmatrix} + \begin{bmatrix} 0 \\ 1/m \end{bmatrix} p = \begin{Bmatrix} \dot{u} \\ \ddot{u} \end{Bmatrix}$$

From the eq. of motion:

$$\ddot{u} = \frac{p(t)}{m} - \frac{c}{m} \dot{u} - \frac{k}{m} u \leftarrow$$

C and D matrices depend on the outputs:

$$y = \begin{Bmatrix} \ddot{u} \end{Bmatrix} = \begin{bmatrix} -\frac{k}{m} & -\frac{c}{m} \end{bmatrix} \begin{Bmatrix} u \\ \dot{u} \end{Bmatrix} + \begin{bmatrix} 1/m \end{bmatrix} p(t)$$

\uparrow for accelerations as outputs

For displacements:

$$y = u = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{Bmatrix} u \\ \dot{u} \end{Bmatrix} + \begin{bmatrix} 0 \end{bmatrix} p(t)$$