controlling a ball by applying a force to keep it in the air

$$y''(t) = \left(\frac{mg - F_A}{m}\right)$$

$$= \frac{F_A}{m} - g$$

$$y'(t) = \int \frac{F_A}{m} - g \, dt$$

$$= \frac{F_A}{m} t - gt + V_0$$

$$y(t) = \int \frac{F_A}{m} t - gt + V_0 \, dt$$

$$= \frac{F_A}{m} t^2 - \frac{g}{2} t^2 + V_0 t + y_0$$

$$X = \begin{bmatrix} y \\ y' \end{bmatrix}$$

$$S_1 = y \qquad S_1' = y' = S_2$$

$$S_2 = y' \qquad S_2' = y'' = \frac{F_A}{m} - g$$

$$\begin{bmatrix} y \\ y' \end{bmatrix}' = \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} y \\ y' \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} \left(\frac{1}{2m} F_A - g\right)$$

input

$$y_n = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} y \\ y' \end{bmatrix}$$

MAKE DISCRETE

$$X = \begin{bmatrix} y \\ y' \end{bmatrix}$$

$$x(t+h) \approx x(t) + h f(x(t), u(t))$$
$$\approx x(t) + h\, x'(t)$$

$$X_{n+1} = X_n + h(AX_n + BU_n)$$

$$X_{n+1} = (Ih + A)X_n + hBU_n$$

h = step size

$$Y_n = CX_n$$