$u_0 := 0\ in$

$u'_0 := 0\ \frac{in}{s}$

$P_0 := 8\ kip$

$t_2 := 0.01\ s$ Time at end of load

$t_1 := \frac{t_2}{2} = 0.005\ s$ Time at Peak Load

$t_n := 2\ s$ Duration of response

$W := 30\ kip$

$k := 3.11\ \frac{kip}{in}$

$m := \frac{W}{g} = 0.078\ \frac{kip \cdot s^2}{in}$

$\omega := \sqrt{\frac{k}{m}} = 6.326\ \frac{1}{s}$

$f := \frac{\omega}{2 \cdot \pi} = 1.007\ \frac{1}{s}$

$T := \frac{1}{f} = 0.993\ s$

$\delta t := min\left(\frac{t_1}{10}, \frac{T}{10}\right) = 0.0005\ s$

t_n

$$n := \frac{t_n}{\delta t} = 4000$$

$$m \cdot u''(t) + k \cdot u(t) = f(t)$$

$$u''(t) + \frac{k}{m} \cdot u(t) = \frac{f(t)}{m}$$

$$u''(t) + \omega^2 \cdot u(t) = \frac{f(t)}{m}$$

$$u''(t) + \omega^2 \cdot u(t) = \frac{f(t)}{m}$$

$$u''(t) = \frac{f(t)}{m} - \omega^2 \cdot u(t)$$

Governing Equation

$$
\begin{aligned}
&Solution := \left\| \begin{array}{l}
\text{for } i \in 0..n-1 \\
\quad \left\| \begin{array}{l}
t_i \leftarrow n \cdot \delta t \\
\text{if } 0 \cdot s \le t_i < t_1 \\
\quad \left\| f_i \leftarrow \dfrac{t_i}{t_1} \cdot P_0 \right. \\
\text{else if } t_1 \le t_i < t_2 \\
\quad \left\| f_i \leftarrow \dfrac{t_2 - t_i}{(t_2 - t_1)} \cdot P_0 \right. \\
\text{else if } t_2 \le t_i \le t_n \\
\quad \left\| f_i \leftarrow 0 \cdot P_0 \right. \\
\text{if } i = 0 \\
\quad \left\| \begin{array}{l} u_i \leftarrow u_0 \\ u''_i \leftarrow \dfrac{f_i}{m} - \omega^2 \cdot u_i \end{array} \right. \\
\text{else if } i = 1 \\
\quad \left\| \begin{array}{l} u_i \leftarrow \dfrac{1}{2} \cdot u''_{i-1} \cdot (\delta t)^2 \\ u''_i \leftarrow \dfrac{f_i}{m} - \omega^2 \cdot u_i \end{array} \right. \\
\text{else if } i > 1 \\
\quad \left\| \begin{array}{l} u_i \leftarrow 2 \cdot u_{i-1} - u_{i-2} + u''_{i-1} \cdot (\delta t)^2 \\ u''_i \leftarrow \dfrac{f_i}{m} - \omega^2 \cdot u_i \end{array} \right.
\end{array} \right. \\
\left[t \;\; f \;\; u \;\; u'' \right]
\end{array} \right.
\end{aligned}
$$

$t := Solution^{\langle 0 \rangle} = \left[[4000 \times 1] \ \boldsymbol{s} \right] \ \boldsymbol{s}$

$f := Solution^{\langle 1 \rangle} = \left[[4000 \times 1] \right] \ \boldsymbol{kip}$

$u := Solution^{\langle 2 \rangle} = \left[[4000 \times 1] \right] \ \boldsymbol{in}$

$u'' := Solution^{\langle 3 \rangle} = \left[[4000 \times 1] \right] \ \frac{\boldsymbol{in}}{\boldsymbol{s}^2}$