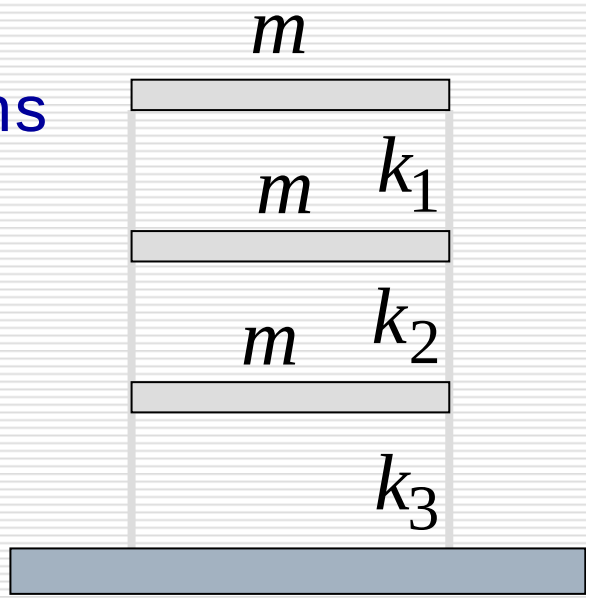
# Assignment 2 (June 29, Submit in two weeks)

Following Example 9.5 and 9.6, compute response displacement, velocity and absolute acceleration at the mass 1 of a 3 DOFS structure shown.




## 1) Structural properties and assumptions

- Assume that

$$m = 150kN / g = 150/9.8$$

$$\xi_r = 0.05$$

$$k_1 = k$$

$$k_2 = 2k$$

$$k_3 = 3k$$

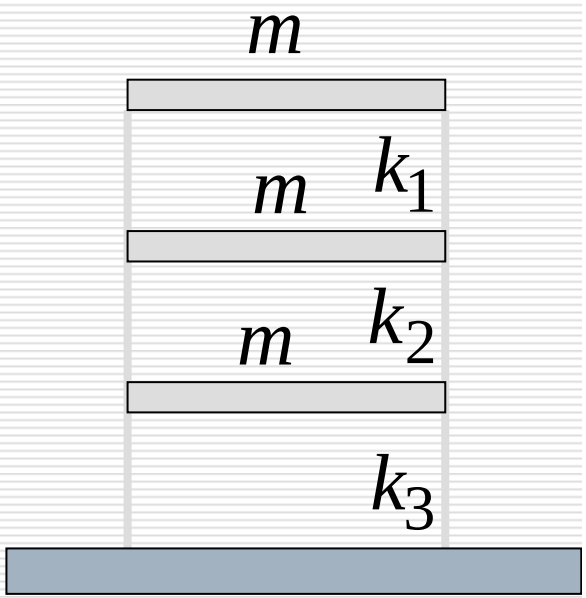
$$k = 3050.9kN/m$$

- Mass matrix

$$[M]=\begin{bmatrix} m & 0 & 0 \\ 0 & m & 0 \\ 0 & 0 & m \end{bmatrix}$$

- Stiffness matrix

$$[K]=\begin{bmatrix} k_1 & -k_1 & 0 \\ -k_1 & k_1+k_2 & -k_2 \\ 0 & -k_2 & k_2+k_3 \end{bmatrix}$$



- The characteristic equation is

$$\begin{vmatrix} k_1 - \omega^2 m & -k_1 & 0 \\ -k_1 & k_1 + k_2 - \omega^2 m & -k_2 \\ 0 & -k_2 & k_2 + k_3 - \omega^2 m \end{vmatrix} = 0$$

$$\begin{vmatrix} k - \omega^2 150/9.8 & -k & 0 \\ -k & 3k - \omega^2 150/9.8 & -2k \\ 0 & -2k & 5k - \omega^2 150/9.8 \end{vmatrix} = 0$$

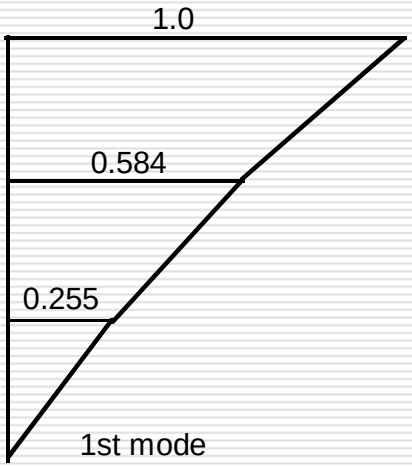
- Natural periods and mode shapes

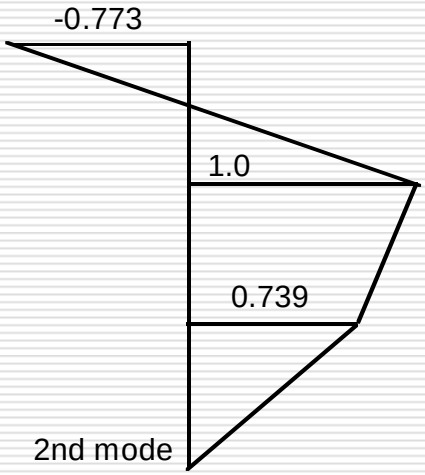
$$\omega_1 = 9.10 rad/s \qquad T_1 = 0.690 s$$

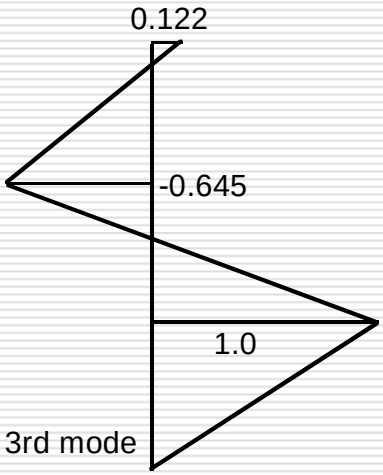
$$\omega_2 = 21.4 rad/s \qquad T_2 = 0.294 s$$

$$\omega_3 = 35.4 rad/s \qquad T_3 = 0.177 s$$

$$\phi_1 = \begin{Bmatrix} 1.00 \\ 0.584 \\ 0.255 \end{Bmatrix} \qquad \phi_2 = \begin{Bmatrix} -0.773 \\ 1.00 \\ 0.739 \end{Bmatrix} \qquad \phi_3 = \begin{Bmatrix} 0.122 \\ -0.645 \\ 1.00 \end{Bmatrix}$$



- Modal matrix

$$[\Phi] = \begin{bmatrix} 1.00 & -0.773 & 0.122 \\ 0.584 & 1.00 & -0.645 \\ 0.255 & 0.739 & 1.00 \end{bmatrix}$$

## 2) Compute response at mass 1 based on the following steps.

- Compute mode participation factors $\beta_1$, $\beta_2$ and $\beta_3$
- Compute response $\tilde{q}_r(t)$, $\dot{\tilde{q}}_r(t)$ and $\ddot{\tilde{q}}_r(t)$
- Compute the generalized coordinate $q_r(t)$, $\dot{q}_r(t)$ and $\ddot{q}_r(t)$
- Compute response at mass 1
- For acceleration, compute the absolute acceleration in stead of the relative acceleration