



The total motion is the sum of the modes.

$$\bar{X}(t) = \underbrace{\sum_{i=1}^{n_r} d_i \bar{X}_i e^{\lambda_i t}}_{\substack{\text{if } \omega=0}} + \underbrace{\sum_{j=1}^{n_i} d_j \bar{X}_j \sin(\omega_j t + \phi_j)}_{\text{if } \lambda=0} + \underbrace{\sum_{k=1}^{n_{ri}} d_k \bar{X}_k e^{\lambda_k t} \sin(\omega_k t + \phi_k)}_{\substack{\lambda \neq 0 \\ \omega \neq 0}}$$

n_r : number of purely real evals

n_i : number of purely imag evals

n_{ri} : num of real + imag evals

$$\underbrace{2n}_{\text{\# of states}} = n_r + 2n_i + 2n_{ri}$$

$d_{i,j,k}$: modal participation factors

$\phi_{j,k}$: phase shifts between oscillating modes

determined by initial conditions, $\bar{X}(0)$

$$\bar{X} = \begin{bmatrix} \bar{C} \\ \bar{S} \end{bmatrix} \quad \begin{matrix} 2n \times 1 \\ 2n \times 2n \\ A \end{matrix}$$