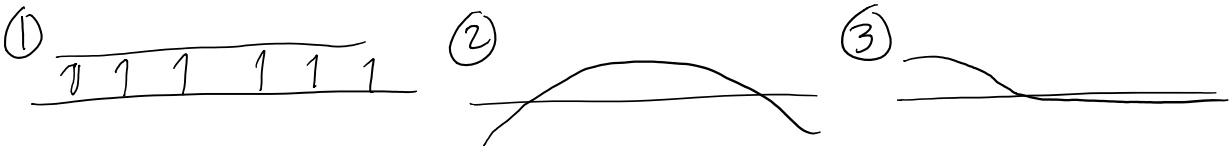
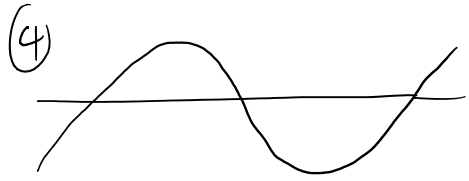
Module 4d: MAC & MSF

Wednesday, November 18, 2020 1:27 PM

Goal → Match mode shapes

Test 

FEM 



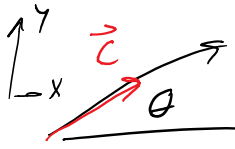
T1 ≙ FEM 2

T2 ≙ FEM 4

MAC Modal Assurance Criterion

$\vec{a} \cdot \vec{b} = \|a\| \cdot \|b\| \cdot \cos\theta$

$\vec{c} = [0.5, 0.3] - \frac{1}{2}$



$\vec{b}$ [0.5; 0.3]

$\vec{a}$ [1; 0]

$$\cos\theta = \frac{[1\ 0]\begin{bmatrix}0.5\\0.3\end{bmatrix}}{(1)\sqrt{0.5^2+0.3^2}} = \frac{0.5+0}{\sqrt{0.5^2+0.3^2}} \rightarrow \theta$$

This also holds for N-dim

$$MAC \triangleq \frac{|a \cdot b|^2}{\|a\|^2 \cdot \|b\|^2} = \cos^2\theta$$

MAC = 1 ~ shape same

(length could be different)

MAC = 0 ~ Totally different (orthogonal)

MAC > 0.9 good match

Lab 3 → MAC ≥ 0.95, 0.99

↑ Measure of similarity between vectors

Cross MAC matlab MAC.m

$MAC([\Phi_{ex}], [\Phi]_{an}) =$

$$\begin{matrix}4\\3\end{matrix}\begin{bmatrix}0 & 0.1 & 1 & 0\\ 0 & 0 & 0 & 0\end{bmatrix}$$

$\Phi_4^{AN} = \Phi_5^{Ex}$

$\Phi^{AN} = \Phi^{Ex}$

$$MAC([\Phi_{ex}], [\Phi]_{an}) =$$

N_{ex} N_{an}

an \ Ex	1	2	3	4	5	6
4	0	0.1	1	0		
3	0	0	0	0		
2	0.2	1	0	0		
1	0.9	0.8	0			

$\Phi_4^{AN} = \Phi_5^{Ex}$

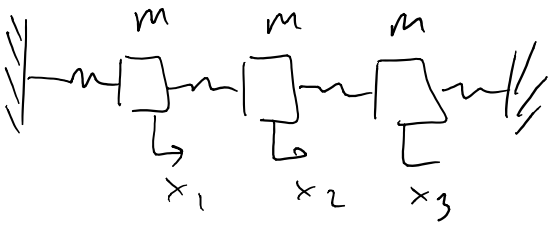
$\Phi_2^{AN} = \Phi_4^{Ex}$

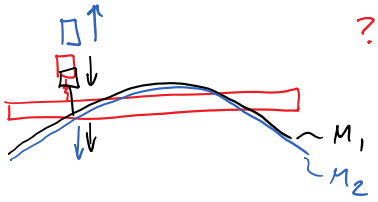
Can't tell Modes $(1,2)^{Ex}$ apart

Both look like Φ_1^{AN}

? Vib. Absorber

Ex:





Meas. on Beam only $\rightarrow M_1 \neq M_2$

$$\Phi = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 0 & -2 \\ 1 & -1 & 1 \end{bmatrix} \qquad \begin{bmatrix} m & 0 & 0 \\ 0 & m & 0 \\ 0 & 0 & m \end{bmatrix}$$

$$\Phi_j^T M \Phi_n = 0 \quad \text{if } j \neq n$$

$$\Phi_j^T \Phi_n = 0 \quad \text{if } j \neq n \longrightarrow \text{Like MAC}$$

$$M = \begin{bmatrix} 3m & 0 & 0 \\ 0 & m & 0 \\ 0 & 0 & m \end{bmatrix} \longrightarrow \Phi_j^T \Phi_n \sim MAC \neq 0 \quad j \neq n$$

TEST $\rightarrow$ meas mass 1, mass 3

$$\Phi^{AN} = \begin{bmatrix} 1 & 1 & 1 \\ 1 & -1 & 1 \end{bmatrix}$$

Self-MAC, AutoMAC

$$MAC([\Phi^{AN}], [\Phi^{AN}]) =$$

an \ an	1	2	3
3	1	0	1
2	0	1	0
1	1	0	1

MSF Modal Scale Factor

an

MSF Modal Scale Factor

$$MSF = \frac{\vec{a}\cdot\vec{b}}{\vec{b}\cdot\vec{b}} = \|b\|^2$$

$$(MSF)^2 = \frac{(\vec{a}\cdot\vec{b})^2}{\|b\|^4}\cdot\frac{\|\vec{a}\|^2}{\|\vec{a}\|^2} = \frac{(\vec{a}\cdot\vec{b})^2}{\|\vec{a}\|^2\|b\|^2}\cdot\frac{\|a\|^2}{\|b\|^2}$$

$$(MSF)^2 = (MAC)\cdot\frac{\|a\|^2}{\|b\|^2}$$

if $MAC \simeq 1$ $\quad MSF \approx \frac{\|a\|}{\|b\|}$

if $MAC \not\simeq 1$ (ignore)