Mechanical Vibration Ⅰ (8)

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System Identification and Harmonic Excitation Response

Identification of system parameter (1)

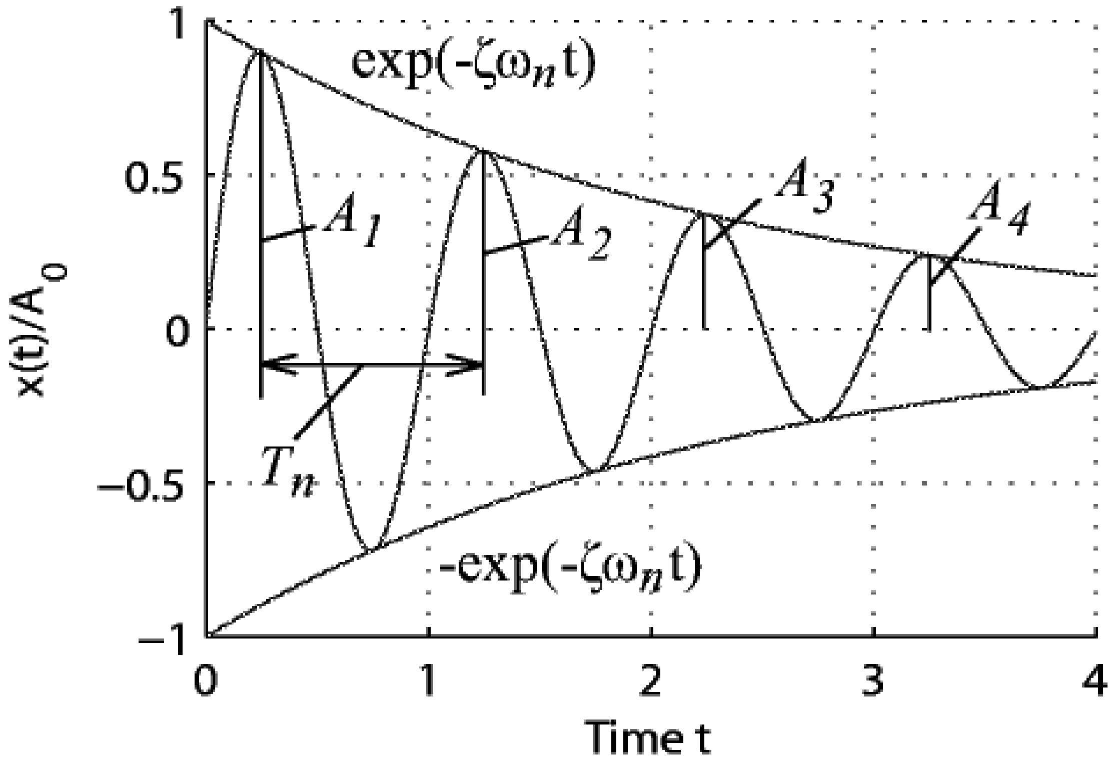

Fig.5 Free vibration of an actual vibration system to be modeled

Identification of system parameter (2)

Natural period T_n

Logarithmic damping ratio $$\delta = \frac{1}{N}\sum_{i=1}^{N}\ln\left(\frac{A_i}{A_{i+1}}\right)$$

Damping ratio $$\zeta = \frac{\delta}{2\pi\sqrt{1+\left(\frac{\delta}{2\pi}\right)^2}}$$

Identification of system parameter (3)

Case 1) *m* can be measured $k = m\omega_n^{\;2} \quad c = 2\sqrt{mk}\,\zeta$

Case 2) *k* can be measured $m = \dfrac{k}{\omega_n^{\;2}} \quad c = 2\sqrt{mk}\,\zeta$

Harmonic exciting force and response (1)

Undamped one degree-of-freedom system

$$\boxed{m\ddot{x} + kx = f}$$

Exciting force

$$f_c = F\cos\omega t$$

$$A = \frac{F}{k - m\omega^2}$$

Response

$$x(t) = A\cos(\omega t + \phi)$$

$$\phi = \begin{cases} 0 & 0 \le \omega < \omega_n \\ -\pi/2 & \omega = \omega_n \\ -\pi & \omega > \omega_n \end{cases}$$

Harmonic exciting force and response (2)

Damped one degree-of-freedom system

$$\boxed{m\ddot{x} + c\dot{x} + kx = f}$$

Exciting force

$$f_c = F\cos\omega t$$

Response

$$x(t) = A\cos(\omega t - \phi)$$

$$A = \frac{F}{\sqrt{(k - m\omega^2)^2 + (c\omega)^2}}$$

$$\phi = \tan^{-1}\left(\frac{-c\omega}{k - m\omega^2}\right)$$