A: The differential equation

\[ \ddot{x} + \omega_0^2 x = 0 \]

has solutions of the form:

\[ x(t) = A \cos \omega_0 t + B \sin \omega_0 t = C \cos(\omega_0 t + \phi) = \text{Re}[De^{i(\omega_0 t + \phi)}]. \]

B: The differential equation

\[ \ddot{x} + \gamma \dot{x} + \omega_0^2 x = 0 \]

has solutions of the form:

For \( \frac{\gamma}{2} < \omega_0 \),

\[ x(t) = Ae^{-\frac{\gamma}{2}t} \cos(\omega_0 t + \phi) \quad \text{where} \quad \omega_0' = \omega_0^2 - \left(\frac{\gamma}{2}\right)^2 \]

\( \frac{\gamma}{2} = \omega_0 \),

\[ x(t) = (B + Ct)e^{-\frac{\gamma}{2}t} \]

\( \frac{\gamma}{2} > \omega_0 \),

\[ x(t) = De^{-(\frac{\gamma}{2} + \Omega)t} + Ee^{-(\frac{\gamma}{2} - \Omega)t} \quad \text{where} \quad \Omega^2 = (\frac{\gamma}{2})^2 - \omega_0^2. \]

C: The differential equation

\[ \ddot{x} + \gamma \dot{x} + \omega_0^2 x = \frac{F_0}{m} \cos \omega t \]

has steady-state solutions of the form:

\[ x(t) = A \cos(\omega t - \delta) \]

where

\[ A = \frac{F_0/m}{\sqrt{(\omega_0^2 - \omega^2)^2 + (\gamma \omega)^2}} \quad \text{and} \quad \tan \delta = \frac{\gamma \omega}{\omega_0^2 - \omega^2}. \]
D: For the case of an $N$-coupled oscillator:

the $n^{th}$ normal mode is given by

$$y_n(x,t) = A_n \sin\left(\frac{n\pi x}{L} + \phi_n\right) \cos(\omega_n t + \delta_n) \quad n = 1, 2, 3, ...$$

where $\omega_n = 2\omega_o \sin\left[\frac{n\pi}{2(N+1)}\right]$ and $\omega_o = \sqrt{\frac{T}{mL}}$.

Also, $\phi_n$ and $\delta_n$ are dependent on the boundary conditions.

E: For the case of a uniform, stretched string:

the $n^{th}$ normal mode is given by

$$y_n(x,t) = A_n \sin\left(\frac{n\pi x}{L} + \phi_n\right) \cos(\omega_n t + \delta_n) \quad n = 1, 2, 3, ...$$

where $\omega_n = \frac{n\pi v}{L} \quad n = 1, 2, 3, ...$

and $\phi_n$ and $\delta_n$ are dependent on the boundary conditions.

F: The Fourier series for the function $f(x)$ defined over the interval $[0, D]$ is given by:

$$f(x) = b_0 + \sum_{n=1}^{\infty} \left[ a_n \sin \left( \frac{2\pi nx}{D} \right) + b_n \cos \left( \frac{2\pi nx}{D} \right) \right]$$

where

$$b_0 = \frac{1}{D} \int_{0}^{D} f(x) \, dx$$

$$a_n = \frac{1}{D/2} \int_{0}^{D} f(x) \sin \left( \frac{2\pi nx}{D} \right) \, dx$$

and

$$b_n = \frac{1}{D/2} \int_{0}^{D} f(x) \cos \left( \frac{2\pi nx}{D} \right) \, dx$$