A: The differential equation \( \ddot{x} + \omega_0^2 x = 0 \)

has solutions of the form:

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

B: The differential equation \( \ddot{x} + \gamma \dot{x} + \omega_0^2 x = 0 \)

has solutions of the form:

\[
 \text{For } \gamma < \omega_0, \quad x(t) = Ae^{-\frac{\gamma}{2}t} \cos(\omega_0 t + \phi) \quad \text{where } \quad \omega_0^2 = \omega_0^2 - \left(\frac{\gamma}{2}\right)^2
\]
\[
 \gamma = \omega_0, \quad x(t) = (B + Ct)e^{-\frac{\gamma}{2}t}
\]
\[
 \gamma > \omega_0, \quad x(t) = De^{-(\frac{\gamma}{2} + \Omega)t} + Ee^{-(\frac{\gamma}{2} - \Omega)t} \quad \text{where } \quad \Omega^2 = \left(\frac{\gamma}{2}\right)^2 - \omega_0^2.
\]

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 displacement of the $p^{th}$ particle in the $n^{th}$ normal mode is given by

$$y_{pn}(t) = A_{pn} \cos(\omega_n t + \delta_n) \quad n = 1, 2, 3, ...$$

For the case of specific boundary conditions, $A_{pn} = C_n \sin\left(\frac{pn\pi}{N+1}\right)$, $\omega_n = 2\omega_o \sin\left[\frac{n\pi}{2(N+1)}\right]$ and $\omega_o = \sqrt{\frac{T}{m\ell}}$.

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

$$b_0 = \frac{1}{D} \int_0^D f(x) dx$$

$$a_n = \frac{1}{D/2} \int_0^{D/2} f(x) \sin\left(\frac{2\pi nx}{D}\right) dx$$

and

$$b_n = \frac{1}{D/2} \int_0^{D/2} f(x) \cos\left(\frac{2\pi nx}{D}\right) dx.$$