Vibration

1. Oscillatory motion
   1. Harmonic motion
      1. Exponential form
   2. Periodic motion
      1. Fourier series where
   3. Vibration terminology
2. Free vibration
   1. Vibration model



* 1. Equations of motion: natural frequency

* 1. Energy method
  2. Reyleigh method: effective mass

* 1. Principle of virtual work
  2. Viscously damped free vibration



For homogeneous equation , assume solution

General solution is given by

Substitute s into general solution x is a symbol of decaying, so whether the damping term is larger, equal or smaller than 0 decides whether the condition of the system.

define damping ratio



* + 1. Oscillatory motion: underdamped case

General solution becomes

* + 1. Non-oscillatory motion

* 1. Logarithmic decrement

* 1. Coulomb damping

1. Harmonically excited vibration 简弦激励
   1. Forced harmonic vibration

When a system is subjected to harmonic excitation, it is forced to vibrate at the same frequency as that of the excitation. Resonance is to be avoided in most cases, and to prevent large amplitudes from developing, dampers and absorbers are often used.



* + 1. Normal representation

assume particular solution



Nondimensional Form:

Amplitude of resonance:

* + 1. Complex frequency response
  1. Rotating unbalance



By letting x be the displacement of the nonrotating mass (M-m) from the static equilibrium position, the displacement of m is

Rearrange:

* 1. Rotor unbalance
  2. Whirling of rotating shafts
  3. Support motion



substitute relative displacement

* 1. Vibration isolation



The force to be isolated is transmitted through the spring and damper

The disturbing force equal to

Transmissibility

* 1. Energy dissipated by damping
  2. Equivalent viscous damping
  3. Structural damping
  4. Sharpness or resonance
  5. Vibration-measuring instruments

1. Transient vibration
   1. Impulse excitation
   2. Arbitrary excitation