

Chapter 19

Mechanical Vibrations

19.1 DEFINITIONS

Mechanical vibration of a system possessing masses and elasticity is motion about an equilibrium position which repeats itself in a definite time interval.

The *period* is the time interval for the vibration to repeat itself.

A *cycle* is each repetition of the entire motion completed during the period.

The *frequency* is the number of cycles in a unit of time.

Free vibrations occur in a system not acted upon by periodic external disturbing forces.

Natural frequency is the frequency of a system undergoing free vibrations.

Forced vibrations occur in a system acted upon by periodic external disturbing forces.

Resonance occurs when the frequency of the forced vibrations coincides with or at least approaches the natural frequency of the system.

Transient vibrations disappear with time. Free vibrations are transient in character.

Steady-state vibrations continue to repeat themselves with time. Forced vibrations are examples of steady-state vibrations.

19.2 DEGREES OF FREEDOM

The degrees of freedom of a system depend on the number of variables (coordinates) needed to describe its motion.

For example, in Fig. 19-1(a), the motion of the mass on a spring that is assumed to vibrate only in a vertical line can be described with one coordinate, and thus possesses a single degree of freedom. A bar supported by the two springs in Fig. 19-1(b) needs two variables as shown, and therefore possesses two degrees of freedom.



Fig. 19-1

19.3 SIMPLE HARMONIC MOTION

Simple harmonic motion can, as shown in Section 12.2, be represented by a sine or cosine function of time. Thus, $x = X \sin \omega t$ is an equation of simple harmonic motion. It could represent the projection on a diameter of a vector of length X as the tip of the vector X rotates on a circular path

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