PHYSICS 232 – CHAPTER 15: MECHANICAL WAVES

Speed of a wave:

$$v = \lambda f = \frac{\omega}{k}$$

where λ is the wavelength, f is the frequency,

$$k = \frac{2\pi}{\lambda}\,, \quad \omega = 2\pi f$$

A wave function $y(x,t)$ describes the displacements of the individual particles in the medium. For a sinusoidal wave moving in the $+x$ direction,

$$y(x,t) = A \sin \omega \left(t - \frac{x}{v}\right) = A \sin 2\pi f \left(t - \frac{x}{v}\right)$$

$$= A \sin 2\pi \left(\frac{t}{T} - \frac{x}{\lambda}\right) = A \sin\left(\omega t - kx\right)$$

The wave function obeys the wave equation:

$$\frac{\partial^2 y(x,t)}{\partial x^2} = \frac{1}{v^2}\,\frac{\partial^2 y(x,t)}{\partial t^2}$$

The speed of a transverse wave on a string with tension F and mass per unit length μ is:

$$v = \sqrt{\frac{F}{\mu}}$$

For a sinusoidal wave on a stretched string, the average power is:

$$P_{av} = \frac{1}{2}\sqrt{\mu F}\omega^2 A^2$$

The wave function of a standing wave on a string with a fixed end at $x = 0$ is

$$y(x,t) = A_{sw} \sin kx \;\cos \omega t$$

On a string of length L with both ends fixed, the frequencies are

$$f_n = n\,\frac{v}{2L} = n f_1, \quad (n = 1, 2, 3, \ldots)$$

f_1 is fundamental, f_2 is first overtone (harmonic), etc.

$$f_1 = \frac{1}{2L}\sqrt{\frac{F}{\mu}}$$