Sound and Doppler Effect

Doppler Effect

$$f_m = f_s \frac{v - v_m}{v - v_s}$$

Supersonic Speed

$$\sin\theta = \frac{v_{sound}}{v_{[planar/[plan]]}} = \frac{1}{M\alpha}$$

Compressibility coefficient

$$\kappa = -\frac{1}{\Delta P} \cdot \frac{\Delta V}{V}$$

Sound Pressure

$$p = -\frac{1}{\kappa} \cdot \frac{\partial s}{\partial x}$$

$$p = \mp p_0 \cos\left[2\pi\left(\frac{t}{T} \pm \frac{x}{\lambda}\right)\right]$$

Pressure Amplitude

$$p_0 = \frac{2\pi s_0}{\kappa\lambda} = Z s_0 \omega$$

Acoustic Impedance

$$Z = \rho v$$

Speed of Sound (Fluid and Gas)

$$v = \frac{1}{\sqrt{\kappa\rho}}$$

$$v = \sqrt{\frac{c_p RT}{c_v M}}$$

Speed of Sound (String and Rod)

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

$$v = \sqrt{\frac{E}{\rho}}$$

Sound Intensity

$$I = \frac{Z}{2} s_0^2 \omega^2$$

$$I = \frac{p_0^2}{2Z}$$

Sound Intensity Level

$$L_I = 10 lg \frac{I}{I_0}$$

$$\text{med } I_0 = 1,0 \cdot 10^{-12}\, W/m^2$$

Refraction and Transmittance of Sound

$$R \equiv \frac{I_r ef}{I_i n} = \left(\frac{Z_2 - Z_1}{Z_2 + Z_1}\right)^2$$

$$T \equiv \frac{I_t r}{I_i n} = 1 - R$$

Harmonics (Strings and Open Cylinders)

$$f_m = m \cdot f_1 \quad m = 2, 3, 4, ...$$

Harmonics (Half Open Cylinders)

$$f_m = (2m - 1) \cdot f_1 \quad m = 2, 3, 4, ...$$