# PS 160 – Physics II for Engineers
# Exam #2 Review
# Chapters 13, 14, 15, 16

## ***SIMPLE HARMONIC MOTION***

Oscillation variables: $x(t) = A\cos(\omega t + \phi)$ $\omega = 2\pi f$ $f = 1/T$

spring: $\omega = \sqrt{\frac{k}{m}}$ simple pendulum: $\omega = \sqrt{\frac{g}{L}}$ physical pendulum: $\omega = \sqrt{\frac{mgd}{I}}$

Energy conservation: $E = \frac{1}{2}mv^2 + \frac{1}{2}kx^2 = \frac{1}{2}kA^2$

## ***WAVE MOTION***

Periodic traveling wave: $y(x,t) = A\cos(kx - \omega t)$ $k = 2\pi/\lambda$ $v = f\lambda = \frac{\omega}{k}$

string: $v = \sqrt{\frac{T}{\mu}}$ fluid: $v = \sqrt{\frac{B}{\rho}}$ ideal gas: $v = \sqrt{\frac{\gamma RT}{M}}$

Standing wave: $y(x,t) = A\cos(kx - \omega t) - A\cos(kx + \omega t) = 2A\sin(kx)\sin(\omega t)$

Resonance conditions (both ends fixed): $f = n\frac{v}{2L}$ $\lambda = \frac{2L}{n}$ $n = 1,2,3,\ldots$

(open-closed): $f = n\frac{v}{4L}$ $\lambda = \frac{4L}{n}$ $n = 1,3,5,\ldots$

## ***FLUIDS***

Density: $\rho = m/V$ specific gravity $= \rho/\rho_{\text{water}}$

Pressure: $p = \frac{F_\perp}{A}$ $p = p_0 + \rho gh$ gauge pressure $= p - p_0$

Buoyant force: $B = \rho_F Vg =$ weight of displaced fluid

Continuity: volume flow rate $= \frac{dV}{dt} = Av =$ constant

Bernoulli: $p + \rho gy + \frac{1}{2}\rho v^2 =$ constant

## ***SOUND***

Bulk modulus (ideal gas): $B = \gamma p_{atm}$

Pressure amplitude: $p_0 = Bks_0$

Intensity: $I_{\text{ave}} = \frac{p_0 s_0 \omega}{2} = \frac{p_0^2}{2v\rho} = \frac{v\rho\omega^2 s_0^2}{2}$

Intensity level: $\beta = (10\,\text{dB})\log\left(\frac{I}{I_0}\right)$ $I_0 = 10^{-12}$ W/m$^2$

Beats: $y(t) = A\cos(\omega_1 t) + A\cos(\omega_2 t) = 2A\cos\left(\frac{\omega_1 - \omega_2}{2}t\right)\cos\left(\frac{\omega_1 + \omega_2}{2}t\right)$

Doppler shift: $f_L = \left(\frac{v + v_L}{v + v_S}\right)f_S$ where $x_L < x_S$