Equation sheet for PHY 300 exam 1. You will be given this sheet in class.

$$A\cos\omega_1 t + A\cos\omega_2 t = 2A\cos\Big(\frac{\omega_1+\omega_2}{2}t\Big)\cos\Big(\frac{\omega_1-\omega_2}{2}t\Big) \;\Rightarrow\; 2Ae^{i\bar{\omega}t}\cos(\Delta\omega\, t)$$

Random phases: $|R| = \sqrt{\sum_{i=1} NA_i^2} \Rightarrow \sqrt{N}|A|$ Identical phases: $|R| = N|A|$

$$\frac{d^2x}{dt^2} + \gamma\frac{dx}{dt} + \omega_0^2 x = \frac{F_0}{m}\cos\omega t \qquad \text{(4-7)}$$

$$\omega_0^2 = \frac{k}{m} \qquad \gamma = \frac{b}{m}\ \text{(3-30)} \qquad Q = \frac{\omega_0}{\gamma}\ \text{(3-37)}$$

$$A(\omega) = \frac{F_0/m}{\Big[(\omega_0^2-\omega^2)^2+(\gamma\omega)^2\Big]^{1/2}} = \frac{F_0}{k}\frac{\omega_0/\omega}{\Big[(\frac{\omega_0}{\omega}-\frac{\omega}{\omega_0})^2+\frac{1}{Q^2}\Big]^{1/2}}\ \text{(4-11; 4-14)}$$

$$\tan\delta(\omega) = \frac{\gamma\omega}{\omega_0^2-\omega^2} = \frac{1/Q}{\frac{\omega_0}{\omega}-\frac{\omega}{\omega_0}}\ \text{for } A\cos(\omega t-\delta)\ \text{(4-11; 4-14)}$$

$$P_{\text{max}} = \frac{QF_0^2}{2m\omega_0}\ \text{(4-24)} \qquad \bar{P}(\omega) = \frac{F_0^2\omega_0}{2kQ}\frac{1}{(\frac{\omega_0}{\omega}-\frac{\omega}{\omega_0})^2+\frac{1}{Q^2}}\ \text{(4-23)}$$

$$\omega^2 = \omega_0^2 - \frac{\gamma^2}{4}\ \text{(3-34)} \qquad \Delta\omega = \frac{\omega_0}{2Q}\ \text{(4-27)} \qquad E(t) = E_0 e^{-\gamma t}\ \text{(3-36)}$$

$$\omega'^2 = \omega_0^2 + 2\omega_c^2 \qquad \omega_n = 2\omega_0\sin\Big[\frac{n\pi}{2(N+1)}\Big]\ \text{(5-25)} \qquad A_{pn} = C_n\sin\Big[\frac{pn\pi}{N+1}\Big]\ \text{(5-26)}$$

$$\frac{\partial^2\psi}{\partial x^2} = \frac{1}{v_p^2}\frac{\partial^2\psi}{\partial t^2}\ \text{(7-9)} \qquad v_p = \frac{\omega}{k} \Rightarrow \frac{c}{n} \Rightarrow \sqrt{\frac{T}{\mu}}\ \text{(7-27)} \qquad v_g = \frac{d\omega}{dk} = \frac{c}{n(\omega)+\omega[dn(\omega)/d\omega]}\ \text{(7-28)}$$

$$n \equiv \frac{\sqrt{\mu\epsilon}}{\sqrt{\mu_0\epsilon_0}} \simeq 1+\chi_e/2 \qquad n = 1 - \frac{n_a e^2}{2m_e\epsilon_0}\sum_j \frac{f_j}{(\omega_j^2-\omega^2)^2+\gamma_j^2\omega^2}\Big[(\omega^2-\omega_j^2)+i\gamma_j\omega\Big]$$

$$\sum_j |f_j| \Rightarrow Z \qquad \omega_p^2 = \frac{n_a e^2 Z}{m_e\epsilon_0} \qquad n_a = \frac{\rho N_A}{A}\ \text{with } N_A = 6.02\times10^{23} \qquad hc = 1240\ \text{eV}\cdot\text{nm}$$

$$m_e = 511\times10^3\ \text{keV}/c^2 = 9.11\times10^{-31}\ \text{kg} \qquad \epsilon_0 = 8.85\times10^{-12}\ \text{C}/(\text{N}\cdot\text{m}^2) \qquad \mu_0 = 4\pi\times10^{-7}\ \text{N/A}^2$$

$$\sin\theta \simeq \theta - \frac{\theta^3}{3!} \qquad \cos\theta \simeq 1 - \frac{\theta^2}{2!} \qquad e^x \simeq 1+x \qquad \sin^2\frac{\beta}{2} = \frac{1}{2}(1-\cos\beta)$$

$$\sin(\alpha\pm\beta) = \sin\alpha\cos\beta \pm \cos\alpha\sin\beta \qquad \cos(\alpha\pm\beta) = \cos\alpha\cos\beta \mp \sin\alpha\sin\beta$$

$$\sin\alpha + \sin\beta = 2\sin\frac{\alpha+\beta}{2}\cos\frac{\alpha-\beta}{2} \qquad \cos\alpha + \cos\beta = 2\cos\frac{\alpha+\beta}{2}\cos\frac{\alpha-\beta}{2}$$