Assignment No. 3

Physics 2P20

Due October 25, 2023

1. A particle undergoing simple harmonic motion has a velocity $\dot{x}_1$ when the displacement is x_1 and a velocity $\dot{x}_2$ when the displacement is x_2. Find the angular frequency and the amplitude of motion in terms of the given quantities.

2. *Kleppner and Kolenkow, 2nd ed.*, Problem 3.19.

3. A damped harmonic oscillator with $m = 10$ kg, $k = 250$ N/m, and $c = 60$ kg/s is subject to a driving force given by $F_0 \cos \omega t$, where $F_0 = 48$ N.

   (a) What value of ω results in steady-state oscillations with maximum amplitude?

   (b) What is the maximum amplitude?

   (c) What is the phase shift?

4. The frequency f_d of a damped harmonic oscillator is 100 Hz, and the ratio of the amplitude of two successive maxima is one half.

   (a) What is the undamped frequency f_0 of this oscillator?

   (b) What is the resonant frequency f_r?

5. *EFTS*, Lorentz model of an insulator.

   Derive the terms for dispersion and absorption parts of the dielectric response, by taking the real part of the time-dependent position, $\Re\{x(t)\}$, of the electronic charge e, under the influence of an external electric field $E_x = E_0 e^{i\omega t}$, *i.e.* solve

$$\ddot{x} + 2\gamma\dot{x} + \omega_0^2 x = -\frac{eE_0}{m_e} e^{i\omega t} \quad .$$

Reminder: the midterm on October 23 will contain problems similar to these.