

PHY 293 Lecture Notes

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Waves and Modern Physics, Fall 2025

PHY293

The up-to-date version of this document can be found at <https://github.com/HaysonC/skulenotes>

Chapter 1

Waves

1.1 Harmonic Oscillators

1.1.1 Governing Equations of Harmonic Oscillators

Types of Harmonic Oscillators There are three types of harmonic oscillators: simple, damped, and driven harmonic oscillators. Consider a simple one dimensional harmonic oscillator, they are defined by the following differential equations:

Definiton 1.1.1.1 (Simple Harmonic Oscillator). A simple harmonic oscillator is described by Hooke's law:

$$m \frac{d^2 x}{dt^2} + kx = 0 \quad (1.1)$$

where k is the spring constant, m is the mass, and x is the displacement from equilibrium.

Definiton 1.1.1.2 (Damped Harmonic Oscillator). A damped harmonic oscillator is described by the following differential equation, by adding a damping term proportional to \dot{x} to the simple harmonic oscillator equation:

$$m \frac{d^2 x}{dt^2} + \gamma \frac{dx}{dt} + kx = 0 \quad (1.2)$$

where γ is the damping coefficient.

Definiton 1.1.1.3 (Driven Harmonic Oscillator). A driven harmonic oscillator is described by the following differential equation, which includes an external driving force $F(t)$:

$$m \frac{d^2 x}{dt^2} + \gamma \frac{dx}{dt} + kx = F(t) \quad (1.3)$$

1.1.2 The Wave Equation

Definiton 1.1.2.1 (The Wave Equation). The wave equation is a second-order linear partial differential equation that describes the propagation of waves, such as sound waves, light waves, and water waves, through a medium. In one dimension, it is given by the following PDE:

$$\frac{\partial^2 u}{\partial t^2} - c^2 \frac{\partial^2 u}{\partial x^2} = 0 \quad (1.4)$$

where $u(x, t)$ is the wave function, c is the speed of the wave in the medium, x is the spatial coordinate, and t is time.

Chapter 2

Modern Physics