Lab -1

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MC312, Modeling and Simulation

In this lab, we numerically and analytically analyze the simple harmonic motion of a spring-mass system for different frequency values. We also look at the impact of different kinds of external impulses on the system. Our main observations are that.....

I. INTRODUCTION

Many systems in sciences and engineering show the property of small amplitude oscillations around a fixed position[2]. In the simplest approximation, such motions can be modeled as a spring-mass system in which on one end of the spring is a rigid support and on the other is a mass. The dynamics depend on both the spring's mass and its flexibility [1]. ......

II. MODEL

Discuss the model in detail. This is the section where one checks the understanding of the model and the type of assumptions that have been used. If there are equations, then write and discuss the equations. As example,

$$\ddot{x} = -\omega^2 x + f(t) \tag{1}$$

Eq. (1) represents the standard equation of a simple harmonic motion with ω being the natural frequency and $f(t)$ being a time-dependent external driving force. Notice that no dissipative effects have been included, and the small angle approximation has been invoked, implying that we retain the lowest order term in the Taylor series expansion of the force around the equilibrium position. The solution in the absence of any driving $f(t) = 0$ is

$$x(t) = A\cos(\omega t + \phi) \tag{2}$$

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III. RESULTS

Fig. 1 shows the typical evolution of the position of the oscillator. Periodic motion is indeed observed etc... Discuss your results in the most intuitive way. What is that you see, why in your opinion the system shows this behavior etc. Figure caption is important and should be self-explanatory. Figure label and legend, if any, should be clear. Show only the relevant part of your results unless there is something that you want to discuss in the non-relevant part. How you showcase your result is also important. For instance, if you want to show the peak amplitude as a function of the maximum value of the driving force, then you should make a figure with such details.

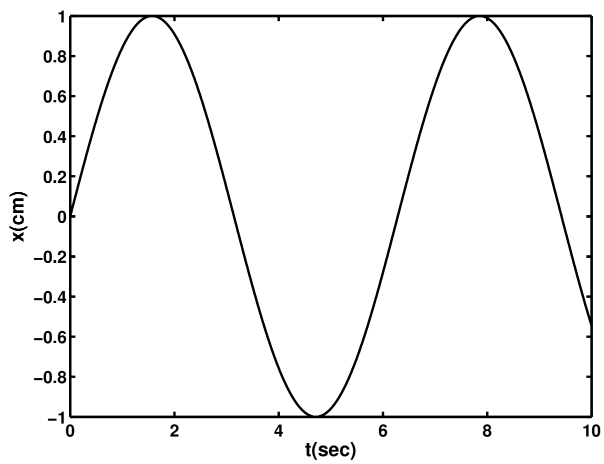

FIG. 1. Typical evolution of the position with time for the simple harmonic oscillator. The initial conditions are $x_0 = 0$ and $v_0 = \sqrt{2}$. The constant $\omega = 1$.

IV. CONCLUSIONS

In conclusion, we have studied a simple mathematical model of a system that shows oscillatory behavior. Discuss your study in a simple way such that a reader will know what has been achieved by the analysis that has been carried out. If, instead, we had a damped harmonic oscillator, we would have observed a range of different behaviors. This is captured in Table. I

$$\ddot{x} + \gamma\dot{x} + \omega^2 x = 0$$

Parameter Value	Behavior	Remarks
$\gamma^2 - 4\omega^2 > 0$	Overdamped	No oscillations
$\gamma^2 - 4\omega^2 < 0$	Underdamped	Decay with oscillations

TABLE I. Table of different behaviors

[1] A. Shiflet and G. Shiflet, *Introduction to Computational Science: Modeling an Simulation for the Sciences*, Princeton University Press.3, 276 (2006).

[2] A. Einstein and N. Rosen, Phys. Rev.**48**, 73 (1935).