Assignment - 3
Harmonic Oscillator

Science-II

Due Date: 14th Feb, 2022

1 Harmonic Oscillator

In this exercise, you will be exploring the microscopic dynamics of a one-dimensional harmonic oscillator using the Hamilton's approach.

$$H(x,p) = \frac{1}{2}kx^2 + \frac{p^2}{2m}$$

Task 1:

Calculate the Hamilton's equations for the above system.

Task 2:

Solve the Hamilton's equations computationally using the finite difference method and study the time evolution of the position and momentum of the oscillator.

Using which, plot the following graphs:

a. Position Vs Time

b. Momentum Vs Time

Task 3:

Plot the trajectory of the system in the phase space.

Task 4:

a. Starting from the initial position, computationally minimize the potential energy of the system by using the steepest decent method (assume that the kinetic energy of the system is zero in this case).

b. Plot position versus potential energy graph as the system decent from the initial position to the minimum.

2 Instructions

- Use Initial Conditions:
  - **a.** k = (ROLL_NUMBER)%3 + 1
  - **b.** m = (ROLL_NUMBER)%5 + 1
  - **c.** x_i = (ROLL_NUMBER)%7 + 1 (Initial Position of the Oscillator)
- Make sure you plot at least 20 points using any appropriate timestep(Δ) such that the total time plotted covers a minimum of one period of the harmonic oscillator, for all given plots.
- Language allowed: Python, Libraries allowed (unless stated otherwise): NumPy, Matplotlib

- Submit a zip file (*Roll_Number.zip*) with one Jupyter notebook (named *Roll_Number.ipynb*) and one PDF file (with answer to Task 1; you can also type the answer on the Jupyter notebook).
- **Plagiarism will be strictly penalised.**

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