FREE UNDAMPED MOTION

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Part 1 :

A. An instance of free undamped motion can be seen in a simple pendulum, which is made up of a mass called the bob attached to a string or rod suspended from a fixed point. Once the bob is pulled away from its resting position and then released, it will begin to sway back and forth with a frequency that is reliant on the length of the string or rod and the gravity's acceleration. This motion is free because there are no external forces such as air resistance or friction acting on the pendulum, and it is undamped because there are no energy losses from dissipation or friction. The amplitude and period of the oscillation remain stable.

A mass-spring system is another example of free undamped motion. This system consists of a mass attached to a spring, which is fastened to a rigid support. When the mass is displaced from its equilibrium position and then let go, it will move back and forth with a frequency that depends on the mass and spring constant. Like the simple pendulum, the motion of this system is free because there are no external forces acting on it, and it is undamped because there are no energy losses. The amplitude and period of the oscillation remain constant.

These two examples serve as illustrations of the idea of free undamped motion, in which a system oscillates without any external forces or energy losses. Engineers employ these systems in various fields (real world uses), including the construction of bridges, buildings, and other structures, to comprehend how oscillating systems operate under different circumstances.

The spring-mass system can usually be used to find the period of any object performing the simple harmonic motion.It governs the motion of a mass-spring oscillator. Understanding this type of motion is essential in several fields, including civil engineering, mechanical engineering, and physics since it provides a basic comprehension of how these systems work and their applications. By exploring free undamped motion, scientists and engineers can create and enhance various oscillatory systems, such as springs, pendulums, and vibrating structures. These systems' performance and optimization are critical in designing practical applications.

B. The differential equations used to describe free undamped motion vary depending on the system under examination. However, they usually consist of second-order differential equations that feature constant coefficients. One such example is the differential equation that describes the motion of a simple pendulum, which can be expressed as,

$$\theta''(t) + (g/L)\sin(\theta(t)) = 0.$$

Here, $\theta(t)$ denotes the angle that the pendulum makes with the vertical at time t, while g represents the acceleration due to gravity and L refers to the length of the pendulum. The prime notation indicates differentiation with respect to time.

Similarly, for a mass-spring system, the equation that governs its motion is,

$$mx''(t) + kx(t) = 0$$

where $x(t)$ denotes the displacement of the mass from its equilibrium position at time t, m represents the mass of the object, and k denotes the spring constant. These second-order differential equations with constant coefficients can be solved analytically to obtain the equations of motion for the system, which describe the changes in the object's position or displacement over time. The solutions to these equations are sinusoidal functions that illustrate the system's oscillatory motion.

Part 2 :

Examples explaining Free Undamped Motion;

- https://www.pinterest.com/pin/ex-3-free-undamped-motion-ivp-problem-spring-system-differential-eq--848295279784688857/
- https://www.youtube.com/watch?v=f2wGE_n5xtA
- https://youtu.be/S5GSaxQEJvQ
- https://youtu.be/aQZ8fTp6NaU
- https://www.wyzant.com/resources/answers/212203/find_its_displacement
- https://ximera.osu.edu/ode/main/springProblemsI/springProblemsI
- https://docs.google.com/document/d/1pOx-4tnqa80b5JMSABLF3qgVWf98uu2482n43LdJXNg/edit
- https://youtu.be/deym3g1_fxM

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- https://openlab.citytech.cuny.edu/https-openlabcitytechcunyedu-poiriermat2680spring2023/2023/04/17/project-2-section-6-1-problem-21/ (Jason Troung)