SPRING MASS OSCILLATIONS

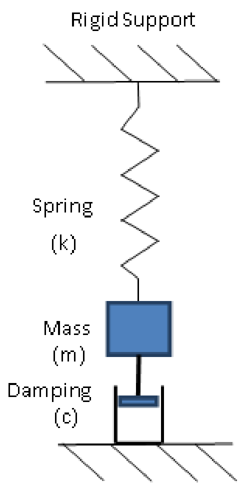
Experiment No. 1 (Theory)

Title: - Free damped oscillation of mass-spring system

Aim: - To obtain damped time period, angular frequency, frequency, logarithmic decrement, damping ratio, natural frequency, initial displacement, initial velocity, initial phase, amplitude, exponentially decaying envelop, u(t), v(t) and a(t).

Apparatus: - Slotted masses on holder, clamp and stand, spring, etc.

Diagram: -



Theory: - The displacement of a free damped spring mass system is given by

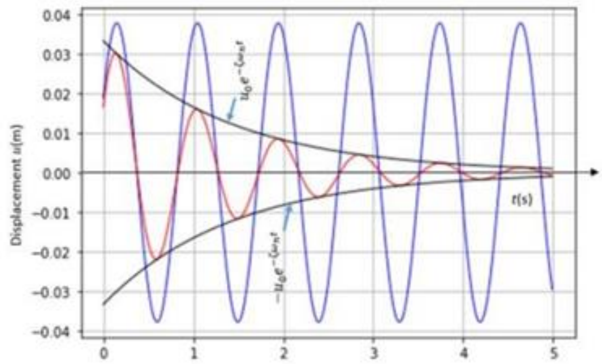
$$u(t) = e^{-\zeta w_n t}(u_0 \sin(w_D t - \Phi_0))$$

where, the amplitude u_0 and phase Φ_0 are given by

$$u_0 = \sqrt{\left(\frac{\dot{u}(0)}{w_n}\right)^2 + \left(u(0)\right)^2}$$

$$\Phi_0 = \tan^{-1}\left(\frac{-u(0)}{\frac{\dot{u}(0)}{w_n}}\right)$$

The typical displacement versus time curve looks like this:



The velocity and acceleration are $v(t) = \dot{u}(t)$ and $a(t) = \dot{v}(t)$. The logarithmic decrement is,

$$\delta = \left(\frac{i}{j}\right) \ln\left(\frac{u_i}{u_{i+j}}\right)$$

And the damping ratio can be calculated from the logarithmic decrement from the relation:

$$\delta = \frac{2\pi\zeta}{\sqrt{1-\zeta^2}}$$

The angular frequency ω_D of a damped system is related with the natural angular frequency ω_n as

$$w_b = w_n\sqrt{1-\zeta^2}$$