Experiment 6

Damped Oscillation

1. Objectives

a) Train student to apply video tracking technique in observing spring damped oscillation.

b) Determining liquid's viscosity value using damped oscillation concept.

2. Apparatus/ Materials

1) Camera
2) Damped Oscillation Apparatus
3) Computer with video analysis software
4) Water, Alcohol, Glycerin

3. Applying Concept

For many systems, non-conservative force (i.e., friction and air friction) will affect system motion. Mechanic energy decreased dependence to time, and we know it as **damped** motion. The lost mechanic energy transform into internal energy of the object and medium due to damping. Figure 1 shows an oscillation spring system that damped in a liquid.

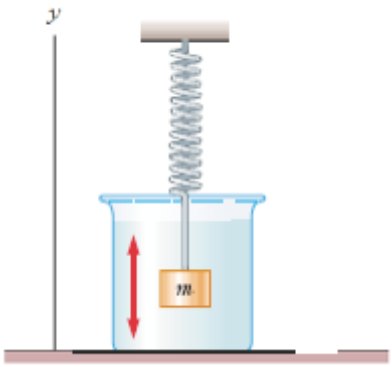

Figure 1. A simple harmonic oscillations damped in *y*-axis

A damped harmonic oscillator occurred due to a friction force that linear to the velocity of an oscillating object. This phenomenon occurs in the friction which involves the flow of viscous fluid, thus it adds force on the object due to the presence of friction whereas

$$F = -bv \tag{1}$$

which $v = dy/dt$ is the velocity and b is the constant that describes the strength of the damping force (kg/s). The negative sign indicates that the force is always opposite to the velocity. The total force on the object is

$$\sum F = -ky - bv \tag{2}$$

According to Newtown's Law II, equation 2 can be written

$$-ky - b\frac{dy}{dt} = m\frac{d^2y}{dt^2} \tag{3}$$

Which has the following solutions

$$y(t) = Ae^{-\left(\frac{b}{2m}\right)t}\cos(\omega' t + \varphi) \tag{4}$$

With the angle frequency of the oscillation

$$\omega' = \sqrt{\frac{k}{m} - \frac{b^2}{4m^2}} \tag{5}$$

4. Procedure

The method used in this experiment is video tracking utilizing Tracker application. Tracker can be used to analyze image and video. The key feature of tracker related to kinematics analysis are tracking of position against time, calculation and graphical representation for velocity, acceleration, and other kinematics. Moving objects video imported into Tracker for further analysis. Tracking results obtained from the analysis are two-dimensional data specifically position and time.