21-R-VIB-SS-52

An m=2kg block rests on a smooth surface and is connected to a long spring (k=18N/m) and viscous damper (c=4Ns/m). If the mass is released with an initial rightward displacement of x=5cm from equilibrium, find the maximum leftward displacement.

Solution

We can use the logarithmic decrement (δ) equation to find the displacement of the first peak in the leftward direction ($x_{1.5}$).

$$\begin{aligned}
\omega_n &= \sqrt{\frac{k}{m}} \\
&= 3 \quad [\text{ rad/s }] \\
\\
\zeta &= \frac{c}{2m\omega_n} \\
&= 0.333 \\
\\
\delta &= \frac{2\pi\zeta}{\sqrt{1-\zeta^2}} \\
\ln\left(\frac{x_i}{x_{i+1}}\right) &= 2.22 \\
\frac{x_i}{x_{i+1}} &= 9.22
\end{aligned}$$

But we want the $x_{1.5}$ peak (starting from $x_1 = 5$cm)

$$\begin{aligned}
\frac{x_1}{x_{1.5}} &= \sqrt{9.22} \\
x_{1.5} &= 1.64 \quad [\text{ cm }]
\end{aligned}$$