Consider the spring-mass system in Figure 1 which is subjected to initial base excitation.

Figure 1.

The variables are:

\[ \begin{align*}
m & = \text{mass} \\
c & = \text{viscous damping coefficient} \\
k & = \text{stiffness} \\
\ddot{x} & = \text{acceleration of the mass} \\
\dot{y} & = \text{acceleration of the base} \\
\end{align*} \]

The governing equation of motion is derived in Reference 1. It can be solved exactly via a Laplace transformation as shown in the reference.

Now assume that the system has a natural frequency of \( f_n = 10 \) Hz and an amplification factor of \( Q = 10 \). The system is subjected to a 0.2 G sinusoidal excitation at a frequency of 10 Hz. The system is thus excited into resonance.
Figure 2.

The Laplace transform solution is performed using Matlab script: sine_base.m.

The problem is also solved using Python script sdof_initial.py which implements the odeint function.

The acceleration and relative displacement results are shown in Figures 2 and 3, respectively. The results are nearly identical in each case.
Figure 3.

Reference