An example to try at home

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Simple Harmonic Motion with Damping

A mass-spring system undergoes simple harmonic motion, where the displacement of the mass at any time t is given by:

$$x(t) = A\cos(\omega t)$$

where:

- A is the amplitude of oscillation (in meters),
- $\omega = \sqrt{\frac{k}{m}}$ is the angular frequency (in radians per second),
- k is the spring constant (in N/m),
- m is the mass (in kilograms).

If the system experiences damping after 5 seconds, the displacement is modified to:

$$x(t) = A\cos(\omega t)e^{-c(t-5)}$$

for $t > 5$, where c is the damping coefficient (in s^{-1}).

Parameters:

- Amplitude $A = 1.0\,\mathrm{m}$,
- Spring constant $k = 10.0\,\mathrm{N/m}$,
- Mass $m = 2.0\,\mathrm{kg}$,
- Damping coefficient $c = 0.1\,\mathrm{s}^{-1}$,
- Time interval: t ranges from 0 to 20 seconds in 0.1-second steps.

Tasks:

1. Calculate the displacement $x(t)$ of the mass for all time intervals t.
2. Use the undamped formula $x(t) = A\cos(\omega t)$ for $t \leq 5$.
3. Apply the damped formula $x(t) = A\cos(\omega t)e^{-c(t-5)}$ for $t > 5$.
4. Print the displacement values for each time step.

Additional help:

1. Use `numpy.cos` function to get cosine.
2. Use `numpy.squrt` function to get a square root.
3. Use `numpy.exp` for exponential.
4. You may use `numpy.zeros(len(t))` to initialize an array with zeros having a length equal to the time array.