Lab 7: Driven Oscillators and Resonance

In this lab you will analyze the behavior of a driven oscillator and plot a resonance curve for multiple drive frequencies.

Warm Up
Grab a sophisticated mass-and-elastic band system and manually drive the system:

1. At a very low frequency below resonance
2. At a very high frequency above resonance
3. At resonance

Q1: How does the motion of your arm compare to the motion of the mass in these three cases? Express this as a phase difference between the arm and mass.

Part I: System Properties
The lab setup consists of a driver (speaker) connected to a mass-spring system damped in a thick fluid. Remember that the equation of motion for the linearly damped harmonic oscillator is

\[ y(t) = A \exp\left(-\frac{t}{2\tau}\right) \cos(\omega t + \phi_0) \]

Q2: Use the MATLAB cftool kit to determine \( \tau, \omega, \) and \( \phi \)

\[ \tau= \quad \omega= \quad \phi= \]

Q3: Calculate the natural frequency \( (\omega_0) \) and the resonant frequency \( (\omega_R) \). Show your work.

Part II: The Damped Driven Oscillator
Select 10 different driving frequencies and measure the amplitude response. This can be measured directly in Logger Pro. Create a plot of Amplitude vs. Angular Frequency. Be sure to drive the oscillator well above and below resonance. Collect most of the data around the resonant frequency. Plot the data in a way that your amplitude is \( = 1 \) when the drive frequency is close to 0 rad/sec.

Overlay a curve that models this behavior.

Q4: How does your overlay compare to the data? If you find the model does not match the data, explain any discrepancies, and provide any “next steps”.