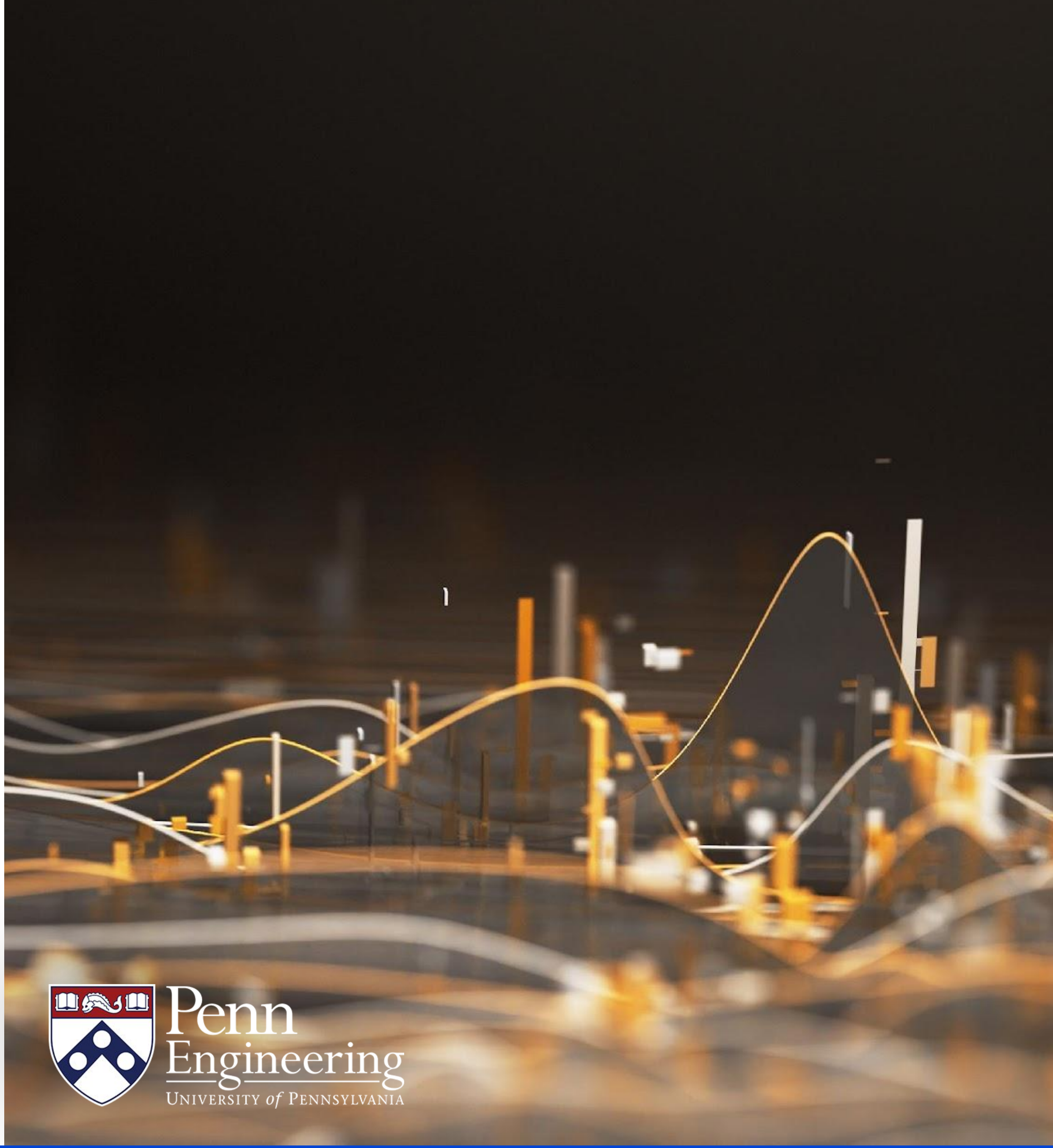
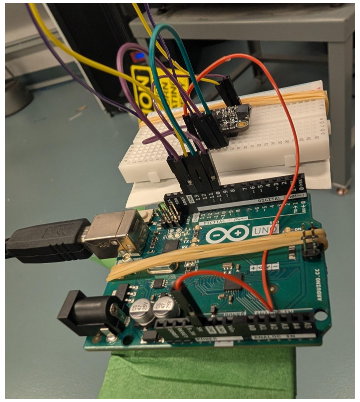
Shake it Off - Final Presentation

103-17: Ashna Khemani, Zach Rudder, Peyton Jenkins & David Kukoyi



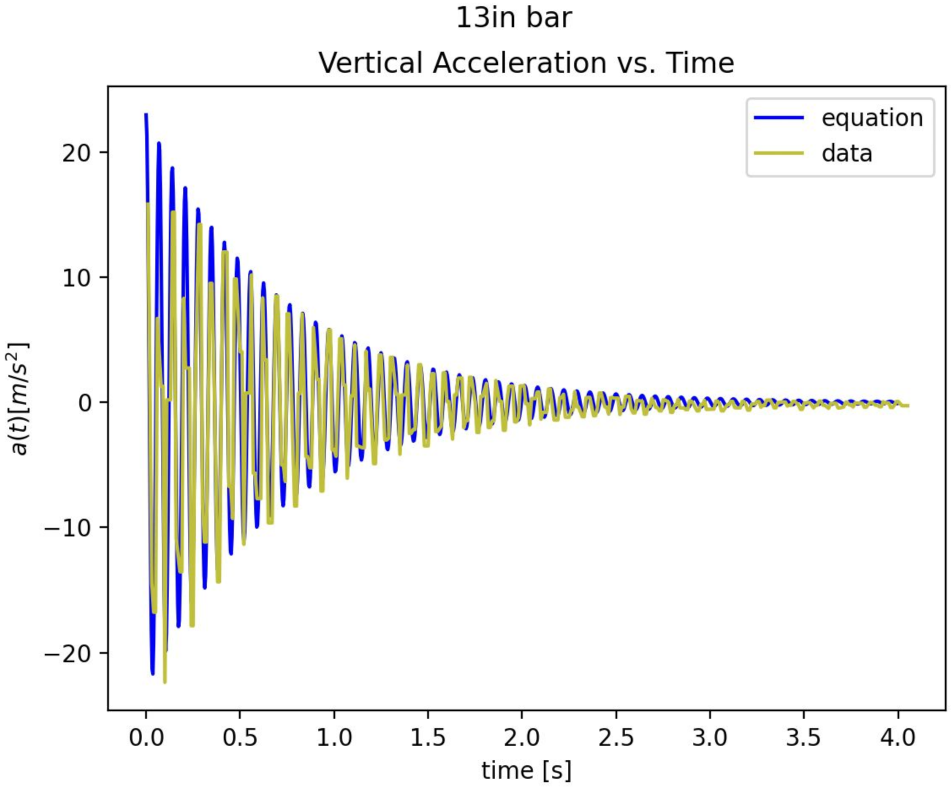
Activity 1: Vibrating Cantilever



- Empirically calculate **frequency** and **damping ratio** of cantilevers of different lengths
  - 3 different lengths: **21.25”, 16.5” & 13”**.
- Collect acceleration data using Arduino → graph and find peaks to find constants, graph representative equation

```
peak1 = (0.9749, 5.8)
peak2 = (1.0353, 5.09)
T_elapsed = peak2[0] - peak1[0]
n = 1   # periods between peaks
delta = (1/n) * np.log(peak1[1]/peak2[1])     # logarithmic decrement
zeta = 1 / (np.sqrt(1 + (2*pi/delta)**2))   # damping ratio
w_d = 2*np.pi / T_elapsed
w_n = w_d / np.sqrt(1-zeta**2)
```

```
decay_fudge = 0.65
osc_fudge = 0.87
X = 23
phi = 0
def soln(t):
    return X*exp((-zeta*w_n*t)*decay_fudge) * cos(osc_fudge*sqrt(1-zeta**2) * w_n*t - phi)
```



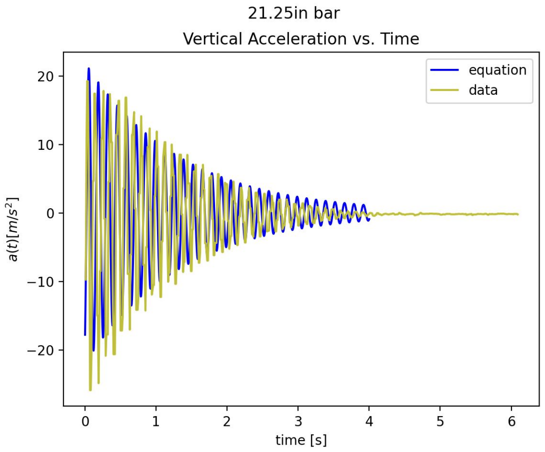

```
omega = 104.04870941766677
zeta = 0.020777979680208065
```

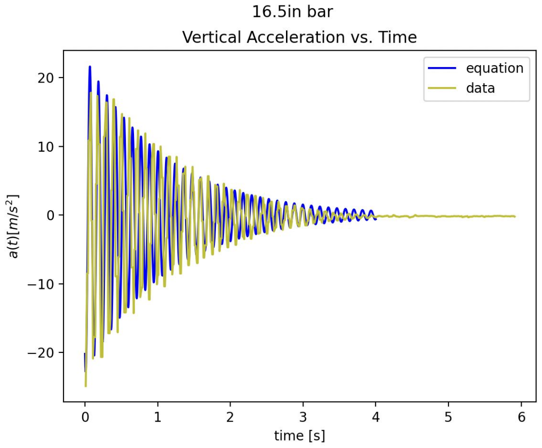
Activity 1 - Data

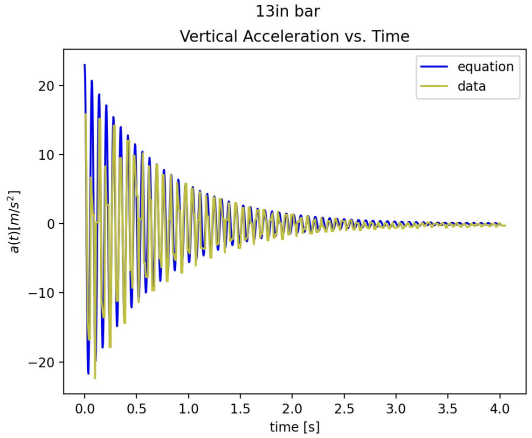
Trial No.	Length (m)	Frequency (Hz)	ζ (Damping Ratio)	*"Fudge Factors"*
1	21.25″	52.372	0.022	*Osc: 0.9* *Dec: 0.65*
2	16.5″	54.2	0.035	*Osc: 0.99* *Dec: 0.47*
3	13″	104.05	0.021	*Osc: 0.87* *Dec: 0.65*

As length decreases

- frequency increases
- damping ratio remains about constant



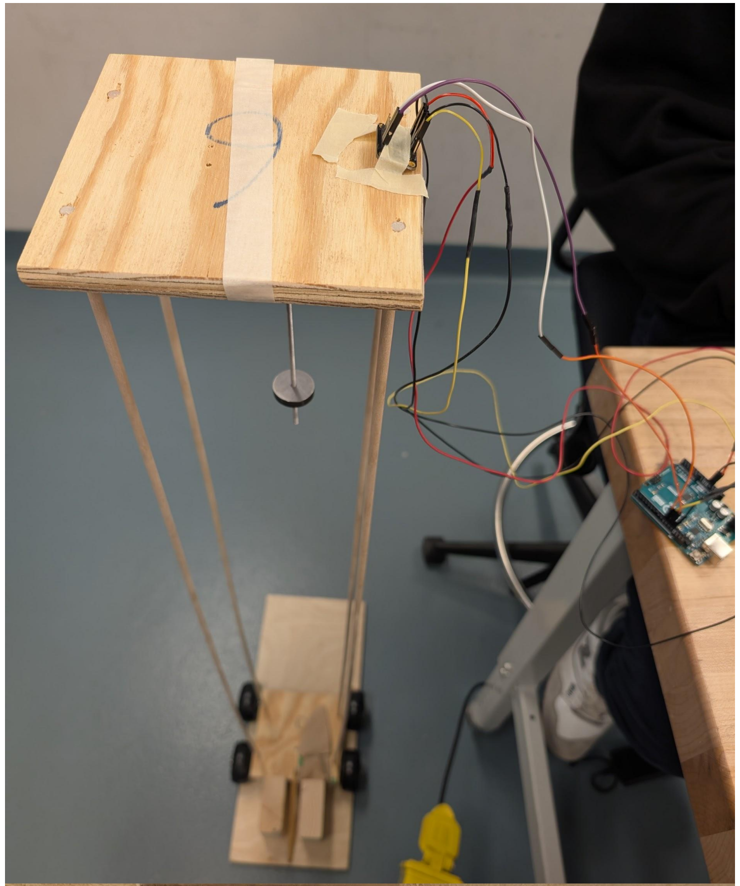




Activity 2: Shaking Tower

$$T = 2\pi\sqrt{\frac{L}{g}}$$

- 3 test scenarios
  - **Fixed mass:** mass is fixed on threaded rod, pivot tightened fully. Changing initial amplitude
  - **Tuned mass:** mass fixed at 70mm on rod. Changing pivot screw tightness
  - **Untuned mass:** pivot screw loosened fully. Mass at arbitrary length. Changing initial amplitude
- Trying to increase damping ratio, perhaps larger period?



Activity 2: Shaking Tower

Fixed mass (fully tight pivot)

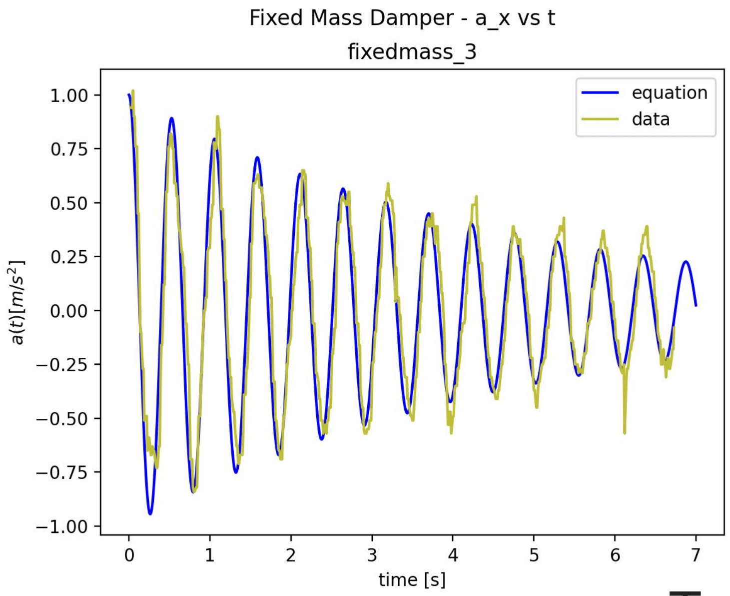
- Avg ζ: 0.03028
- Avg T: 0.5595 [s]

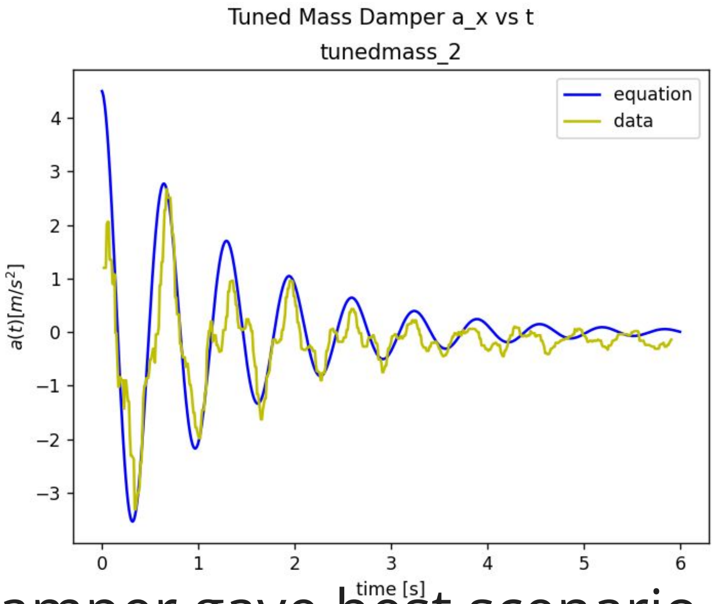
Tuned mass (adjusting damping) - best case

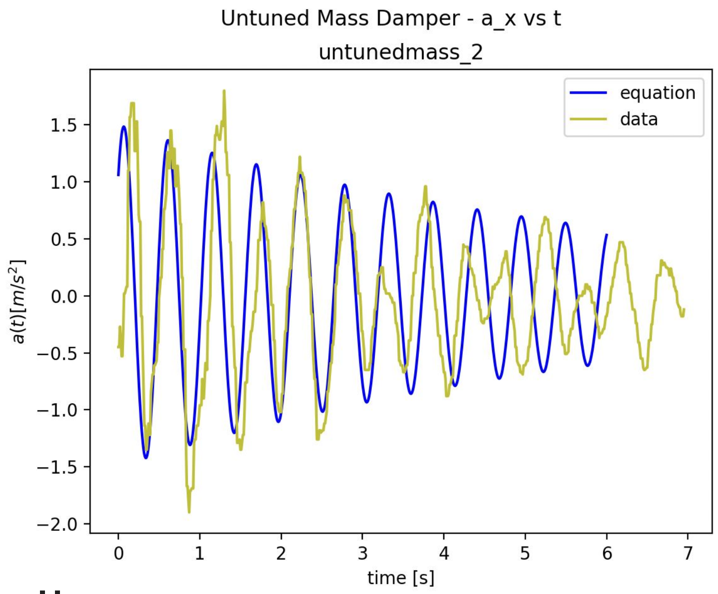
- Avg ζ: 0.078
- Avg T: 0.648 [s]

Untuned mass (fully loose pivot)

- Avg ζ: 0.0174
- Avg T: 0.5046 [s]
- erratic







- → Tuning damper gave best scenario overall
  - Double the damping ratio as the fixed mass
  - Slightly higher period than the fixed mass

Prediction

- Recreate test environment: fix mass at 70mm on threaded rod, medium tightness pivot screw
- Screw tightness medium-high should give us a damping ratio of 0.07
- Something like this graph