LE 3.1 – DA32435 – Dyab Asdi – 19305

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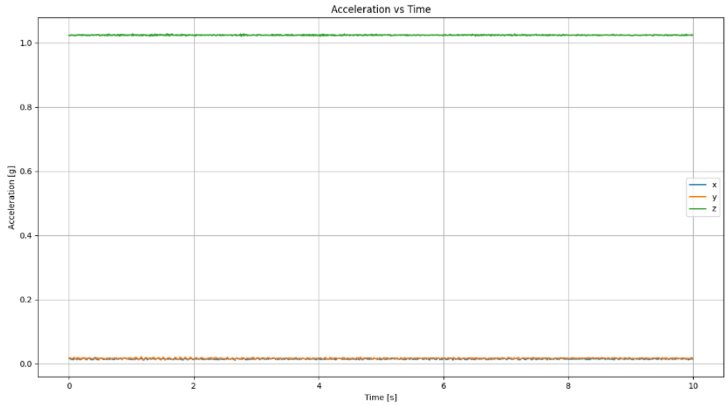
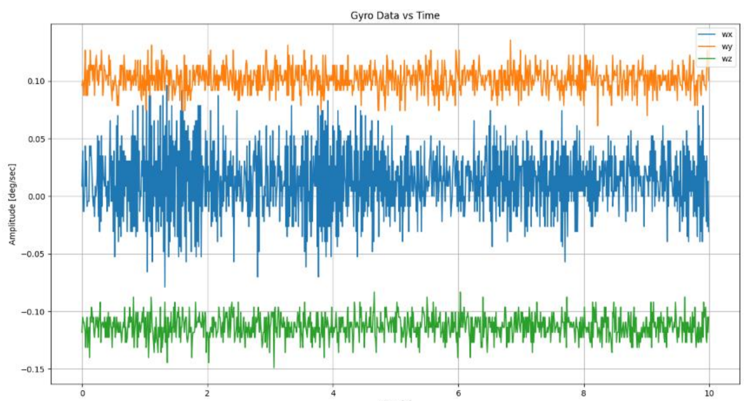
1)



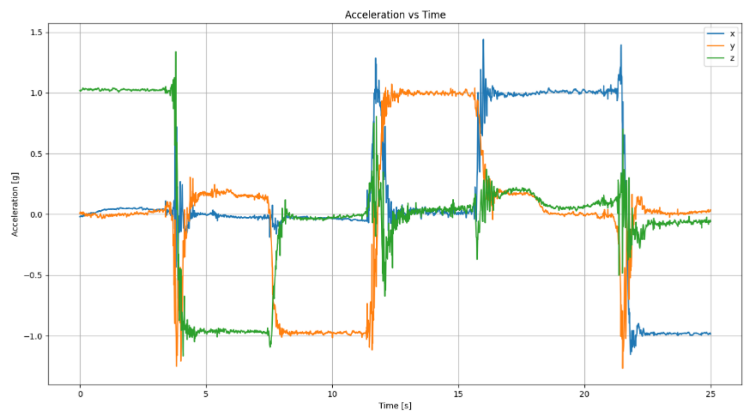
Acceleration vs Time			
Axes	**X**	**Y**	**Z**
Mean	0.01532	0.01727	1.02405
Standard Deviation	0.00125	0.00130	0.00142



Gyro Data vs Time			
Axes	**X**	**Y**	**Z**
Mean	0.01347	0.10185	-0.11313
Standard Deviation	0.03071	0.01072	0.01011

2)

2-G Calibration Test



3)

Schematic of Circuit and Beam System:

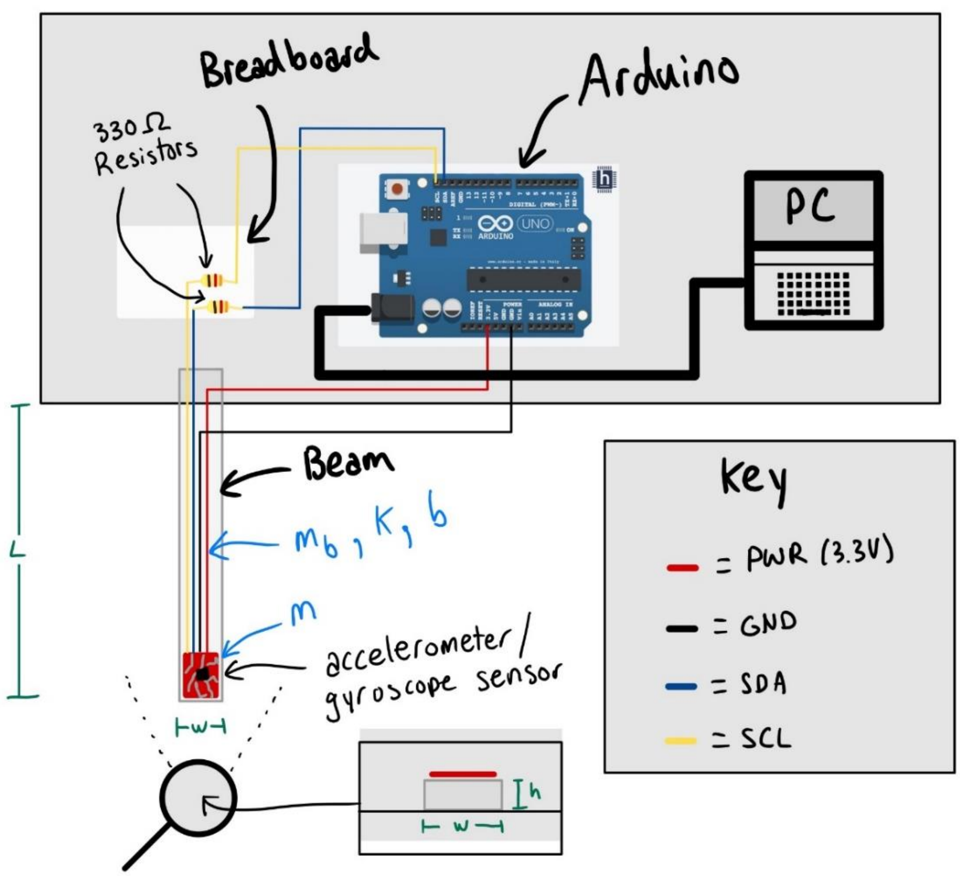
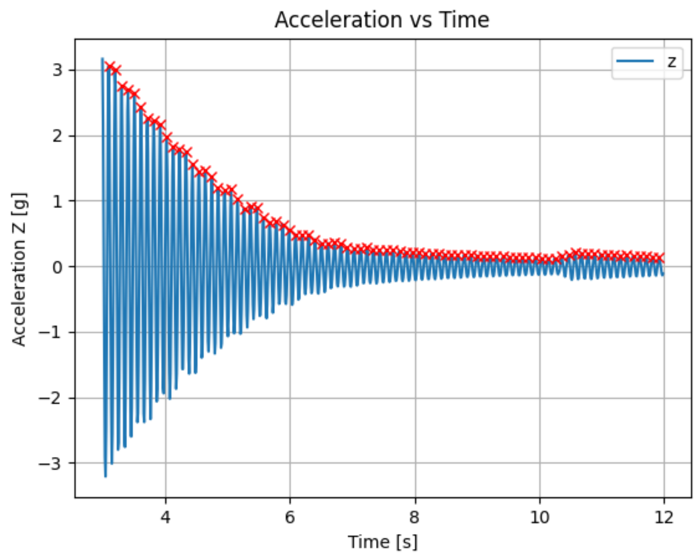
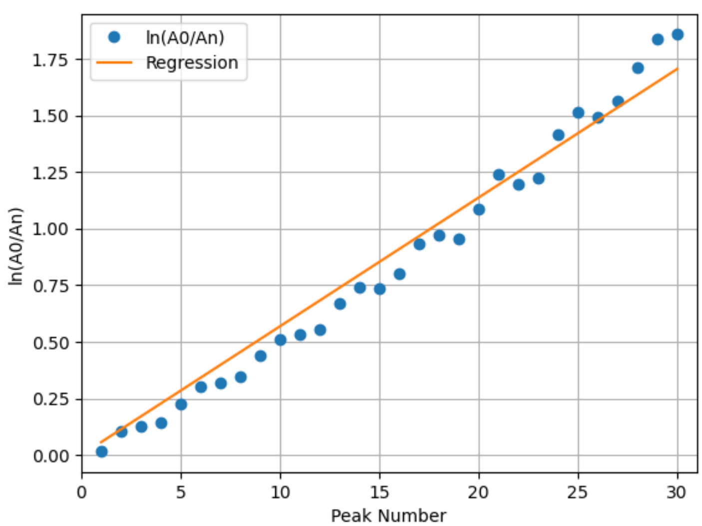


Table of Measured and Calculated Values						
Characteristic	Length	Height	Width	Young's Modulus (€)	Moment of Inertia	Density (ρ)
Value	0.36 m	0.0025 m	0.025 m	68.9 GPa	$3.26 \times 10^{-11}\, m^4$	2700 kg/m^3

4)





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Theoretical Stiffness and Natural Frequency Bounds:
Theoretical Stiffness [N/m] = 144.22
Omega_n Min [rad/s] = 33.403395
Omega_n DH  [rad/s] = 41.816849
Omega_n Max [rad/s] = 45.883929
-----------------------------------------------------------
-----------------------------------------------------------
Experimental Signal Freq. [Hz] = 9.6372
Experimental period [s]        = 0.1038
Damped Natural Freq. [rad/s]   = 60.5522
-----------------------------------------------------------
-----------------------------------------------------------
Beta (slope) =  0.05686
R squared    =  0.97519
Zeta         =  0.00905
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Experimental Damped and Natural Frequencies Results:
Omega_d Exp [rad/s] = 60.552239
Omega_n Exp [rad/s] = 60.554719
-----------------------------------------------------------
-----------------------------------------------------------
Effective Mass [kg] = 0.039329
Percentage of beam mass in Effective Mass [%] = -0.48
(Compare to DH Method value of 23%)
-----------------------------------------------------------
-----------------------------------------------------------
Damping Coefficient, b [N*s/m] = 0.04310
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5) We first measured the length, width, and height of the beam, and from there we were able to calculate its moment of inertia. Knowing the beam's material, we found its density and Young's Modulus. With these values, we were able to calculate the mass of the beam. For the theoretical K value, we used the relationship below:

$$K = \frac{3EI}{L^3} = 144 \ N/m$$

Using equations derived in lecture, I was able to calculate the Zeta value using the slope of the regression for the following equation:

$$\ln\left[\frac{A_0}{A_n}\right] = \left[\frac{2\pi\zeta}{\sqrt{1-\zeta^2}}\right] n$$

The slope of this equation is represented as Beta, in the python script "beamanalysis.py" and is equal to the following equation, as shown below:

$$\beta = \left[\frac{2\pi\zeta}{\sqrt{1-\zeta^2}}\right]$$

From the linear regression graph, Beta = 0.056856, and using these relationships, I was able to solve for Zeta = 0.009049. From this, since we knew the experimental damped frequency, I used this to calculate the experimental natural frequency with the relationship below:

$$\omega_n = \frac{\omega_d}{\sqrt{1-\zeta^2}} = 60.5547$$

Now that we have obtained the natural frequency value of 60.5547, we can use this to solve for the effective mass, as shown below:

$$M_{eff} = \frac{K}{\omega_n^2} = 0.039329 \text{ Kg}$$

We can use the effective mass to solve for the damping ratio, b, for the system, with the following relationship:

$$b = 2\zeta\omega_n M_{eff} = 0.0431 \ \frac{N \cdot s}{m}$$

With the effective mass, mass of the beam, and mass of the accelerometer/gyroscope, we can solve for gamma, the percentage of the beam's mass that is accounted for in the effective mass, using the following relationships:

$$M_{eff} = M + \gamma m_b \rightarrow \gamma = \frac{M_{eff} - M}{m_b} = -0.48$$

We found that gamma = -0.48, which is significantly different from the expected result of 0.23, or 23%. This could be due to human error from the calibration of the accelerometer during part 1 of the lab.

See "Table of Measured and Calculated Values" in section 3 for summary of the setup data.