Calculation requirements(10')

Plot details(6')

Shaker Experiment(4 plots total)(1')(include error bars)

Amplitude vs. Frequency plot *(3 length)* *(for each plot it should include 2 lines: input & output. Seems like the plot in the lab video)-use shaker.txt data file()*

Wd & wn plot (3length)*(put wd and wn in one plot, it should looks like 6 single points)*

Hammer Experiment (18 plots total - 6*3 different length)(3=6*0.5')(include error bars)

1. **Voltage vs. Time *(Input)*** *-use hammar**dat**.txt data file*
2. **Voltage vs. Time *(Output)*** *-use hammar**dat**.txt data file*
3. **Amplitude vs. Frequency *(Input)*** *-use hammar**fft**.txt data file*
4. **Amplitude vs. Frequency *(Output)*** *-use hammar**fft**.txt data file*
5. **Magnitude of response vs. Frequency** *(which is |H(f)|) -use hammar**fft**.txt data file*
6. **Phase Lag vs. Frequency** *(which is arctan(f)) -use hammar**fft**.txt data file*

Simulation (8 plots total- 2*4 effects)(2=4*0.5')

(Effects of length, damping coefficient, end mass, material type)

1. **Magnitude of Response vs. Frequency**
2. **Phase Angle vs. Frequency**

Tables(3')

<u>All experiment items should ± uncertainty (4'=6*0.5'+1'(uncertainty))</u>

Simulation 3.1-

Length (inches) Theoretical	Frequency(Hz) Simulated	Theoretical Natural Frequency(Hz)
16		
20		
24		

Simulation 3.2-

Damping Coefficient	Theoretical ωn(rad/s)	Simulated Natural Frequency (Hz)	Damping Ratio (ζ)	Damped Frequency (Hz)
1				
3				
5				
7				
9				

Simulation 3.3.1-

End Weight (kg)	Theoretical Frequency (Hz)	Simulated Natural Frequency (Hz)	Theoretical ωn(rad/s)
0.25			
0.40			
0.60			

Simulation 3.3.2-

Material	Theoretical Frequency (Hz)	Simulated Frequency (Hz)	Theoretical ωn(rad/s)	Spring Constant Keq(KN/m)
Stainless Steel				
Carbon Steel				
Aluminum				

Shaker Experiment-(±uncertainty)

Length of Beam(inches)	Theoretical Natural Frequency $\omega n(\mathrm{rad/s})$	Damped Frequency $\omega d(\mathrm{rad/s})$	Experimental Natural Frequency (Hz)	Damping Ratio(ζ)	Spring Constant Keq (KN/m)
16 ± 1/64					
20 ± 1/64					
24 ± 1/64					

Hammer Experiment-(±uncertainty)

Length of beam(inches)	Theoretical Natural Frequency $\omega n(\mathrm{rad/s})$	Damped Frequency $\omega d(\mathrm{rad/s})$	Experimental Natural Frequency (Hz)	Damping Ratio(ζ)	Spring Constant Keq (KN/m)
16 ± 1/64					
20 ± 1/64					
24 ± 1/64					

Code(5’)

Write up (5’)

Tips:

where x_0 and x_1 are amplitudes of any two successive peaks.

For system where $\zeta \ll 1$ (not too close to the critically damped regime, where $\zeta \approx 1$).

$$\zeta \approx \frac{\ln(\frac{x_0}{x_1})}{2\pi}$$

x is the magnitude of the systems output.

System Transfer Function: $H(f) = \frac{\hat{y}(f)}{\hat{x}(f)}$

Where $\hat{x}(f)$ is the input to the system, and $\hat{y}(f)$ is the output of the system.

Use fast Fourier transform funvtion-----------fft()

$\hat{x}(f$=fft(input);
$\hat{x}(f\hat{y}(f)$=fft(output).

Magnitude of Response: $|H(f)| = \sqrt{\mathrm{Re}(H(f))^2 + \mathrm{Im}(H(f))^2}$

Phase Lag/Lead: $\phi(f) = \mathrm{atan}\left(\frac{Im(H(f))}{Re(H(f))}\right)$