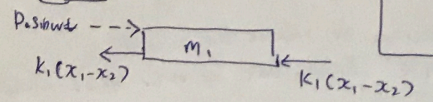
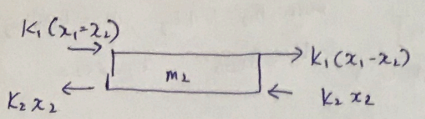
FBD for mass 1 and 2





$$-2k_1(x_1-x_2) = m_1\ddot{x}_1$$

$$2k_1(x_1-x_2) - 2k_1x_2 = m_2\ddot{x}_2$$

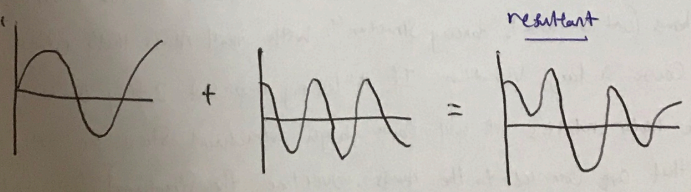
Q1 Does the system vibrate harmonically? Why not?

- From the experiment both the wave form are not vibrating in harmonic motion but rather more complex / complicated motion. From the general solution it's an addition of 2 sinusoidal waves which will create a complex waveform and not a harmonical waveform.

Q2 Does striking on mass 1 and mass 2 produce similar vibration wave forms? Explain,

From the waveforms of strike mass 1 and 2 are not similar. From the graph the peaks and other aspects performs differently. From the theory, the solution of equation (4) were $\begin{bmatrix} x_1 = x_1(\omega_1) + x_1(\omega_2) = r_1B_1\sin(\omega_1 t+\phi_1) + r_2B_2\sin(\omega_2 t+\phi_2) \\ x_2 = x_2(\omega_1) + x_2(\omega_2) = B_1\sin(\omega_1 t+\phi_1) + B_2\sin(\omega_2 t+\phi_2) \end{bmatrix}$ the displacement of x_1 and x_2 Summation of 2 sinusoidal wave will result a complicated wave form. Also without the oscillator scope we would not know how the system would behave.

Ex.

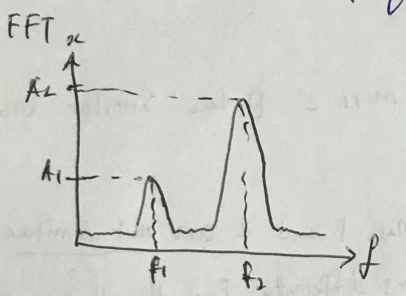


Complicated wave form.

Question 3

Can you use the vibration amplitude against time plots to measure the natural frequencies of the system? How do you measure it?

Yes. Using of Fast Fourier Transform we can find the natural frequency, and where measuring of the peak to peak that will gives the amplitude. the 2nd method is by making use of the data that was collected from the forced vibration and with that it can allow us to plot the graph with voltage vs frequency getting the similar results.



Question 4

Suppose test rig represent 2 story building. By installing a motor on roof (mass 1), discuss the potential vibration problems and recommend actions to reduce vibration level.

From the video shown when the motor is attached to roof (mass 1). The figure shows (out of phase), "dancing structure". With small mass that's rotating can actually cause a large vibration. If the test rig represent 2 story building and when the motor rotates it will cause high structural stress on both the pillars that are connected to the mass. overtime, the structure will fail and collapse.

- Recommend action to ~~dec~~ reduce vibration: 1) Force Reduction and mass addition
  2) Tuning and Isolation
  3) Damping (material, active feedback, etc.)

[Vibration Control]

Question 5

Would Vibration level increase, decrease or remain unchanged if motor is installed at mass 2? Explain one's for motor speed close to resonances

mass: $m_1 = 1.4\,kg$, $m_2 = 1.06\,kg$

$k_1 = 8800$ $\quad k_2 = 8520$

$$A_{top} = \frac{m_0 \Omega^2 e \left[2(k_1+k_2) - \Omega^2 m_2\right]}{m_1 m_2 (\Omega^2 - \omega_1^2)(\Omega^2 - \omega_2^2)}$$

$$A_{bellow} = \frac{2 m_0 \Omega^2 e k_1}{m_1 m_2 (\Omega^2 - \omega_1^2)(\Omega^2 - \omega_2^2)}$$

$\left|\frac{A_{bellow}}{A_{top}}\right| > 1$ increase

$= 1$ remain the same

< 1 decrease

$$\left|\frac{A_{bellow}}{A_{top}}\right| = \left| \frac{\frac{2 m_0 \Omega^2 e k_1}{m_1 m_2 (\Omega^2 - \omega_1^2)(\Omega^2 - \omega_2^2)}}{\frac{m_0 \Omega^2 e \left[2(k_1+k_2) - \Omega^2 m_2\right]}{m_1 m_2 (\Omega^2 - \omega_1^2)(\Omega^2 - \omega_2^2)}} \right| \Rightarrow \frac{2 m_0 \Omega^2 e k_1}{m_0 \Omega^2 e \left[2(k_1+k_2) - \Omega^2 m_2\right]}$$

$$= \left[\frac{2(8800)}{\left[2(8800+8520) - \Omega^2 (1.06)\right]}\right] > 1$$

$\therefore$ A bellow = higher

$$B_{top} = \frac{2 m_0 \Omega^2 e k_1}{m_1 m_2 (\Omega^2 - \omega_1^2)(\Omega^2 - \omega_2^2)}$$

$$B_{bellow} = \frac{m_0 \Omega^2 e \left[2(k_1+k_2) - \Omega^2 m_2\right]}{m_1 m_2 (\Omega^2 - \omega_1^2)(\Omega^2 - \omega_2^2)}$$

$\left|\frac{B_{bellow}}{B_{top}}\right| > 1$ increases

$= 1$ remain

< 1 decrease

$$\left|\frac{B_{bellow}}{B_{top}}\right| = \left| \frac{2(k_1+k_2) - \Omega^2 m_2}{2 k_1} \right| \Rightarrow \left[\frac{2(8800+8520) - \Omega^2 (1.06)}{2(8800)}\right] < 1$$

$\Rightarrow$ Vibration level will increase when installed at mass 2.

From the equation we can see when the position of Ω is in numerator / demominator it will affect on wether Vibration will be higher or lesser.

When motor is placed at mass 2, mass 1 will Vibrate at higher level according to ratio $\left[\frac{A_{bellow}}{B_{bellow}} > \frac{A_{top}}{B_{top}}\right]$