MODAL ANALYSIS - Single Hammer Strike

Modal analysis is the field of measuring and analysing the dynamic response of structures and or fluids during excitation. Examples would incl measuring the vibration of a car's body when it is attached to an electromagnetic shaker, the noise pattern in a room when excited by a loudspeaker, or a body hit with a single hammer strike.

$data_1 := READPRN("Hammer Strike.txt")$

PARAMETERS;

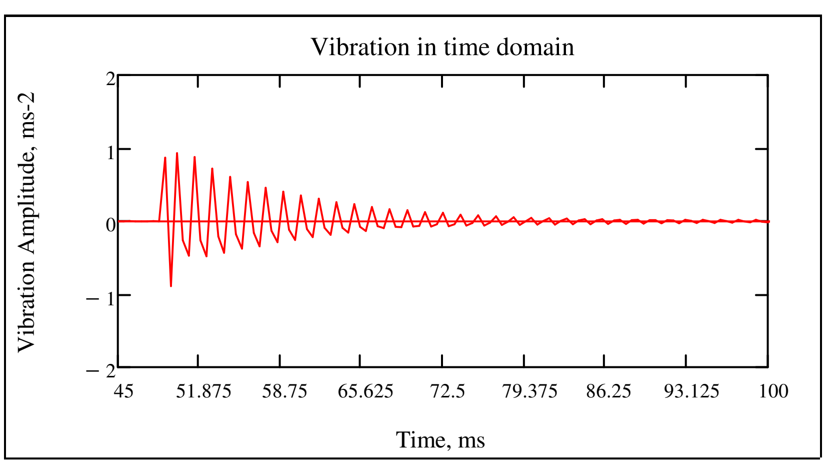
$i := 0..2000$ $asen := \frac{10.32}{9.8}$ Unit in mV/ms^2 Asen >>> Unit in mV/ms^2

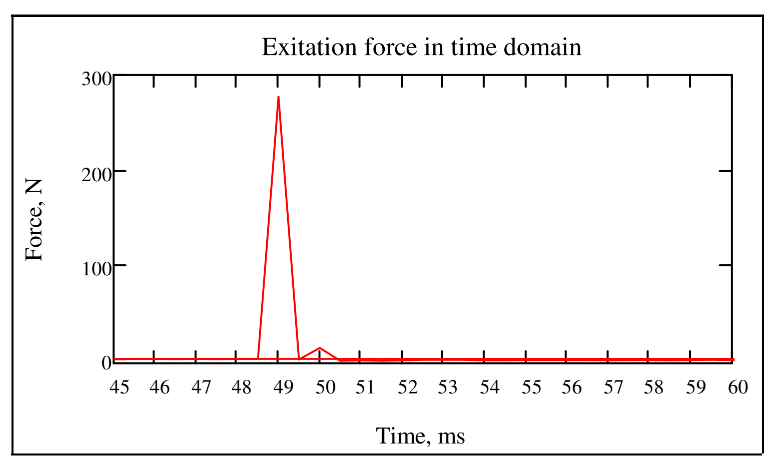
$time_i := 0.5 \cdot i$ $Fsen := 1.1487737$ Unit in mV/N Fsen >>> $\frac{5.11}{4.44822162} = 1.1487737$ Unit in mV/N

NOTE
1. i = impuls range.
2. asen = Sensitivity of accelerometer. 10.32 mV/gravity (or mV/ms^{-2}). Convert to displacement, so divided by 10.32 mV/ms^2: 9.8 ms^2
3. Fsen = Sensitivity of tip force.
4. asen is the output of acceleration. It can be integrated to be displacement.
5. Fsen is the input. Namely Force.

Detection of the vibration form by using the graph of force and acceleration in Time Domain

$M^{\langle 0 \rangle} := time$ Force: $M^{\langle 11 \rangle} := (data_1)^{\langle 1 \rangle} \cdot Fsen$ Amplitude: $M^{\langle 12 \rangle} := (data_1)^{\langle 2 \rangle} \cdot asen$





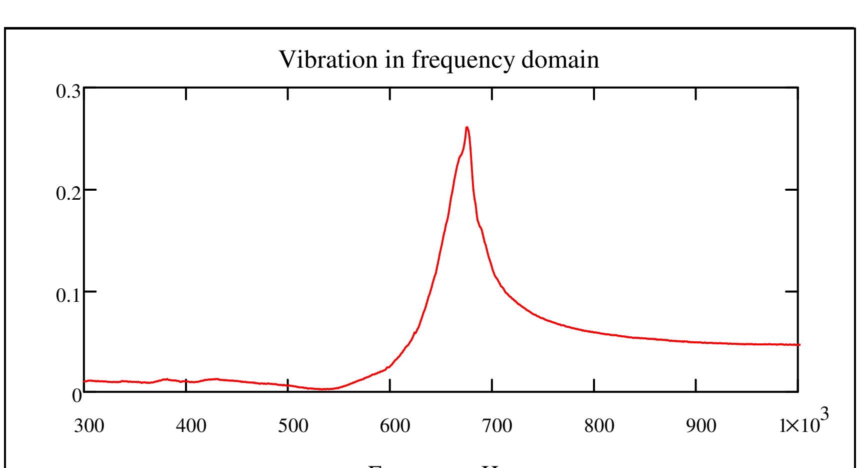
Detection of the vibration form by using the graph of force and acceleration in Frequency Domain

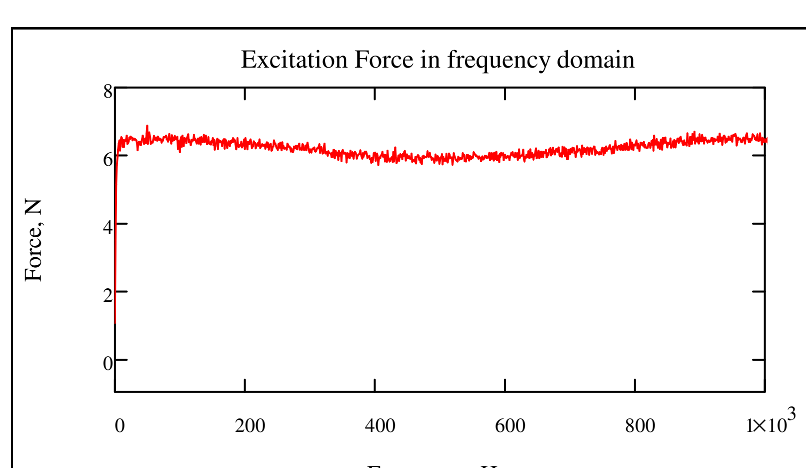
$f_i := \frac{i}{2003 \cdot 0.5 \cdot 10^{-3}}$

NOTE
1. Accelerometer has frequency range from 0 ... 2000.
2. Remeber that F and A are input and output, respectevely.

Force $F1 := cfft\left(M^{\langle 11 \rangle}\right)$

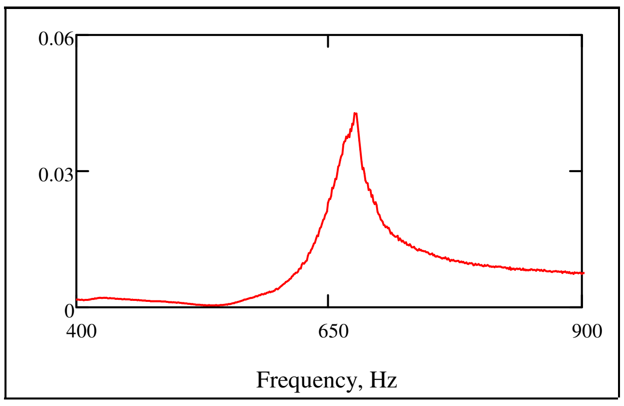
Acceleration $A1 := cfft\left(M^{\langle 12 \rangle}\right)$

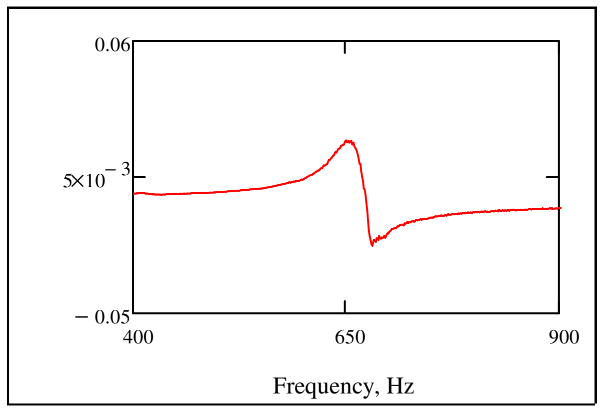


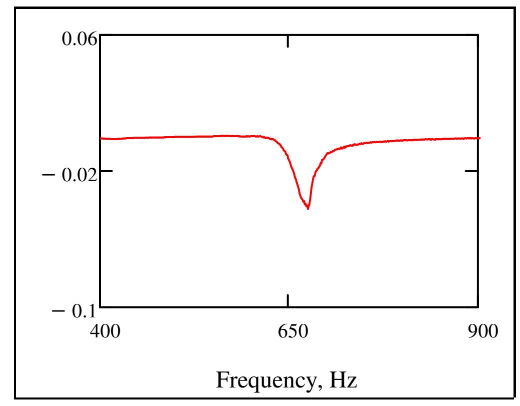


Making Transfer function (TF)

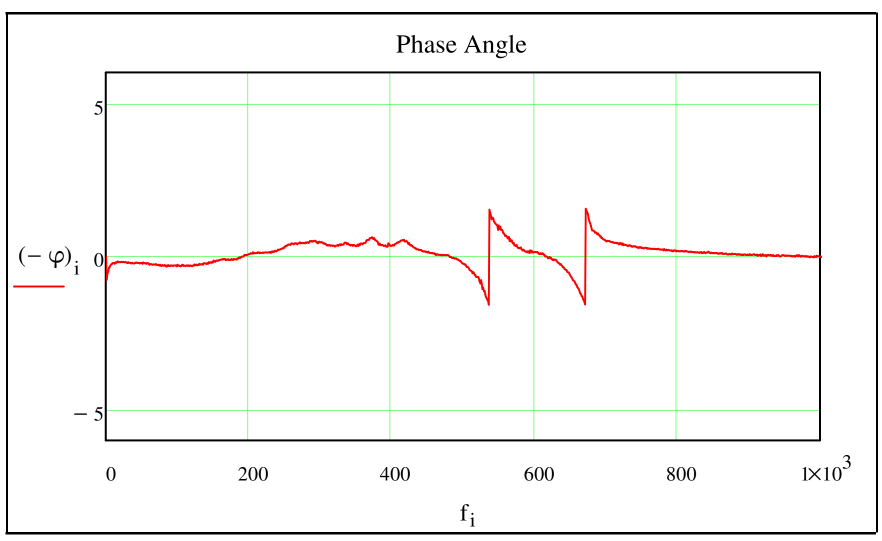
$$TF1 := \frac{A1}{F1}$$







$$\varphi := \operatorname{atan}\left(\frac{Im(TF1)}{Re(TF1)}\right)$$



$$f_i := \frac{i}{2003 \cdot 0.5 \cdot 10^{-3}} \qquad \Omega := 0..1000 \qquad m := 0.82 \qquad k := 373500 \qquad c := 40 \qquad \omega n := \sqrt{\frac{k}{m}} \qquad \zeta := \frac{c}{2 \cdot m \cdot \omega n}$$

$$fn(\Omega) := \frac{1}{\sqrt{\left[1-\left(\frac{\Omega}{\omega n}\right)^2\right]^2 + \left[2 \cdot \zeta \cdot \left(\frac{\Omega}{\omega n}\right)\right]^2}}$$

$$Ke(\Omega) := \frac{1}{k} \cdot \frac{\left[1-\left(\frac{\Omega}{\omega n}\right)^2\right]}{\left[1-\left(\frac{\Omega}{\omega n}\right)^2\right]^2 + 4 \cdot \zeta^2 \cdot \left(\frac{\Omega}{\omega n}\right)^2}$$

$$Imag(\Omega) := \frac{-1}{k} \cdot \frac{2 \cdot \zeta\left(\frac{\Omega}{\omega n}\right)}{\left[1-\left(\frac{\Omega}{\omega n}\right)^2\right]^2 + 4 \cdot \zeta^2 \cdot \left(\frac{\Omega}{\omega n}\right)^2}$$