$ORIGIN := 1$ L San Andres (c) 2019

Single frequency force

Physical parameters and natural frequency

$K := 150 \cdot 10^6 \cdot \frac{N}{m} = 8.565 \times 10^5 \cdot \frac{lbf}{in}$ stiffness and mass

$\zeta := 0.05 \cdot 3$ damping ratio

$M := 300 \cdot kg = 661.387 \cdot lb$

$f_n := \frac{\omega_n}{2 \cdot \pi} = 112.54 \cdot Hz$ natural frequency and

natural period of motion

$\omega_n := \left(\frac{K}{M}\right)^{.5} = 707.107\ s^{-1}$

$T_n := \frac{1}{f_n} = 8.886 \times 10^{-3}\ s$

$C := \zeta \cdot 2 \cdot (K \cdot M)^{.5} = 363.392 \cdot lbf \cdot \frac{s}{in}$ Damping coefficient

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$F_I := 100 \cdot N$ $f_I := 50 \cdot Hz$ **frequency of forcing function**

$F(t, T) := F_I \cdot \sin\left(2\pi \cdot \frac{t}{T}\right)$ $\omega_I := f_I \cdot 2 \cdot \pi$ $T_{max} := (N_P - 1) \cdot \frac{1}{\Delta rate} = 0.102\ s$

Hanning window

$T_I := \frac{1}{f_I}$ for graphs $freq_{max} := 500 \cdot Hz$ $T_M := T_I \cdot 10 = 0.2\ s$

Sampling rate = MIN = 2 x max frequency

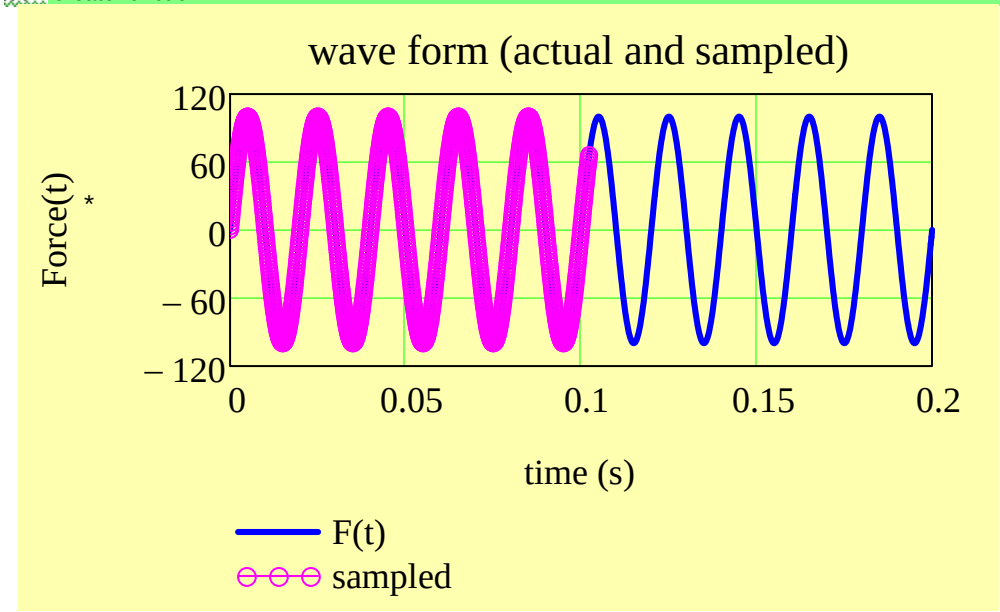
Sampling rate $\Delta rate := 10000 \cdot 1 \cdot \frac{1}{s}$ **samples/s**

Number of samples $N_P := 2^{10} = 1.024 \times 10^3$

1 YES, 0: NO $Y_{window} := 0$

Sampling must be at least twice larger than freq of forcing function

Create function



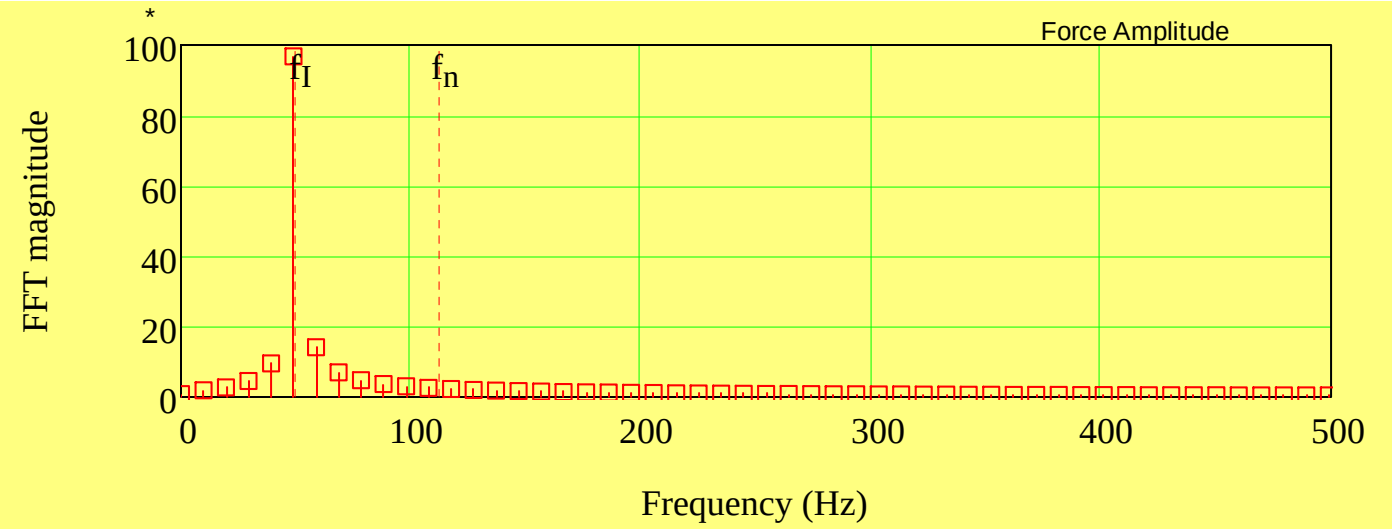
$$\frac{T_{max}}{T_I} = 5.115 \quad \text{cycles}$$

$$\frac{\Delta t}{T_I} = 5 \times 10^{-3}$$

f=50 Hz

$$FI_{max} := F_I$$

Create FFT



$$\Delta f = 9.785 \cdot Hz$$

$$T_{max} = 0.102\ s$$

$$f_{max} = 5 \times 10^{3} \cdot Hz$$

$$\frac{f_{max}}{\Delta f} = 511$$

f=50 Hz

R & I parts of FX

Build system response (frequency and time)

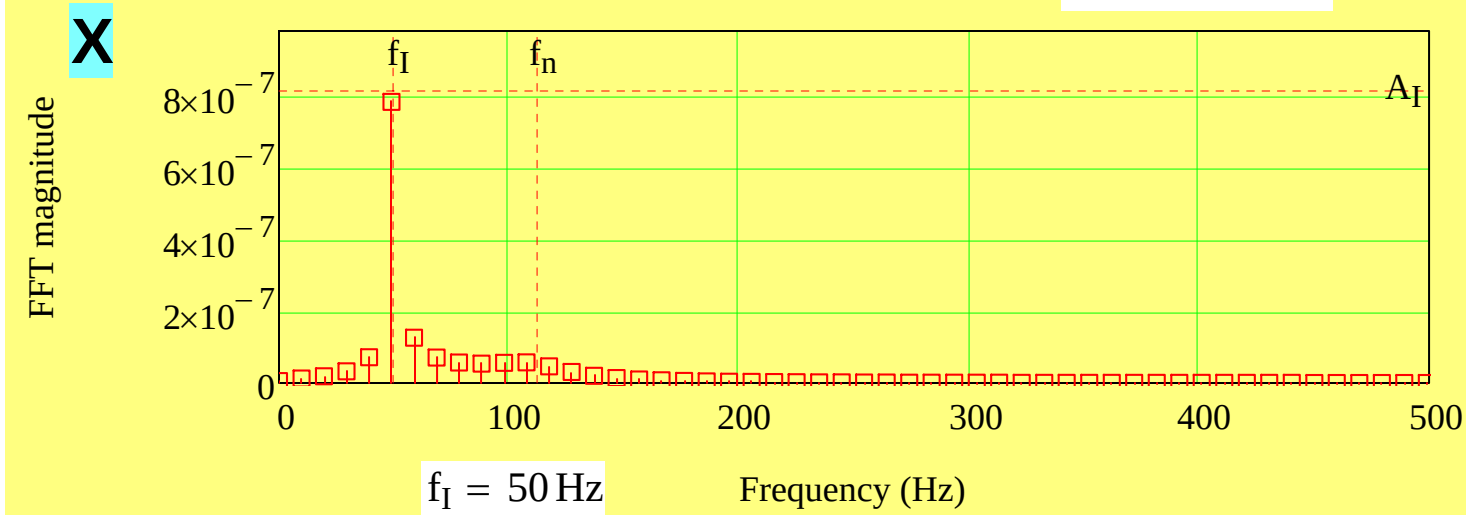
$$A_I := \frac{F_I}{\left|K - M\cdot(\omega_I)^2 + i\cdot C\cdot\omega_I\right|} = 8.194\times10^{-7}\,m$$

exact value

$$A_{max} := \max(A) = 7.855\times10^{-7}\,m$$

$$\frac{A_{max}}{A_I} = 0.959$$

$f_n = 112.54\cdot Hz$



$f_I = 50\,Hz$

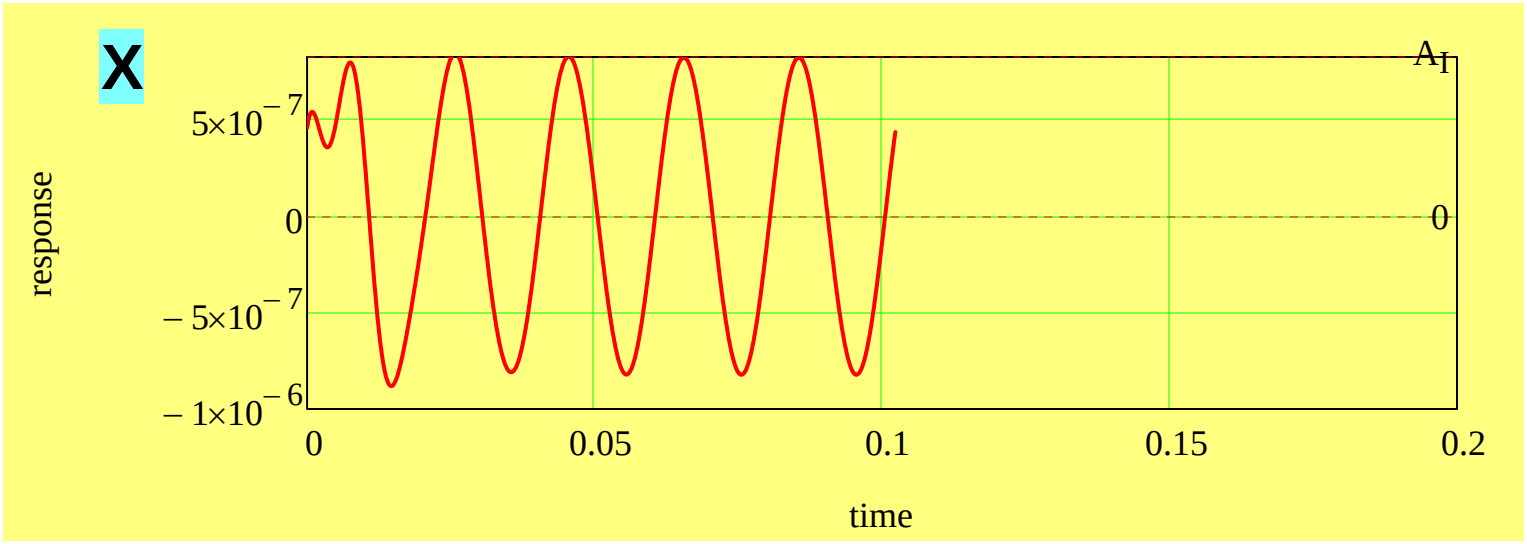
$\Delta f = 9.785\,Hz$

$f_{req_9} = 78.278\,Hz$

(b) Time response

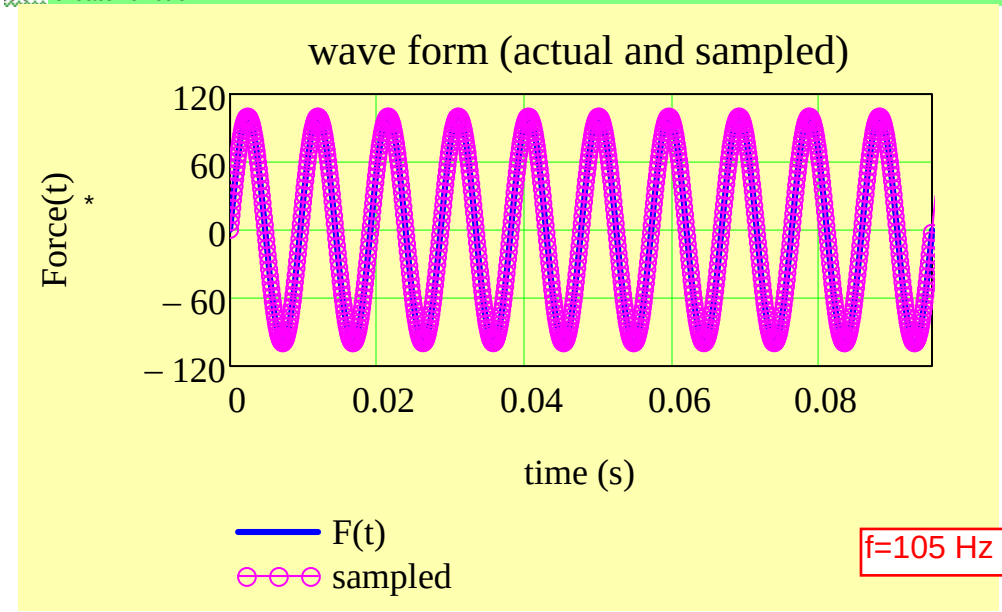
$\max(X) = 8.39 \times 10^{-7}\,\text{m}$

$A_I = 8.194 \times 10^{-7}\,\text{m}$ exact response



f=50 Hz

Create function



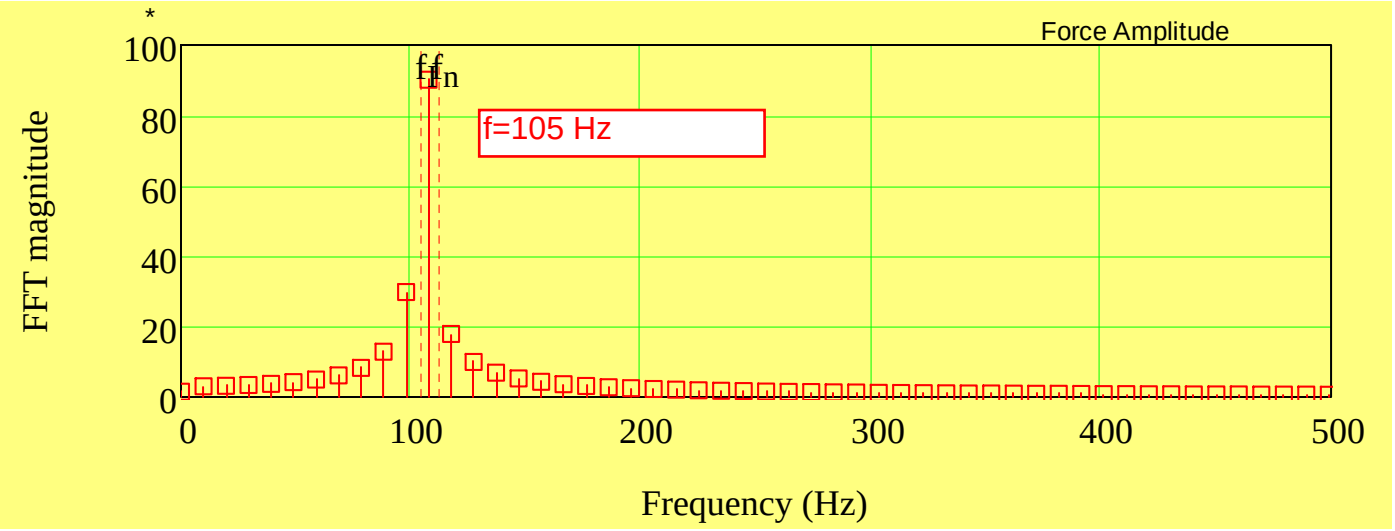
f=105 Hz

$$\frac{T_{max}}{T_I} = 10.741 \quad \text{cycles}$$

$$\frac{\Delta t}{T_I} = 0.011$$

$$FI_{max} := F_I$$

Create FFT



$$\Delta f = 9.785 \cdot Hz$$

$$T_{max} = 0.102\ s$$

$$f_{max} = 5 \times 10^3 \cdot Hz$$

$$\frac{f_{max}}{\Delta f} = 511$$

R & I parts of FX

Build system response (frequency and time)

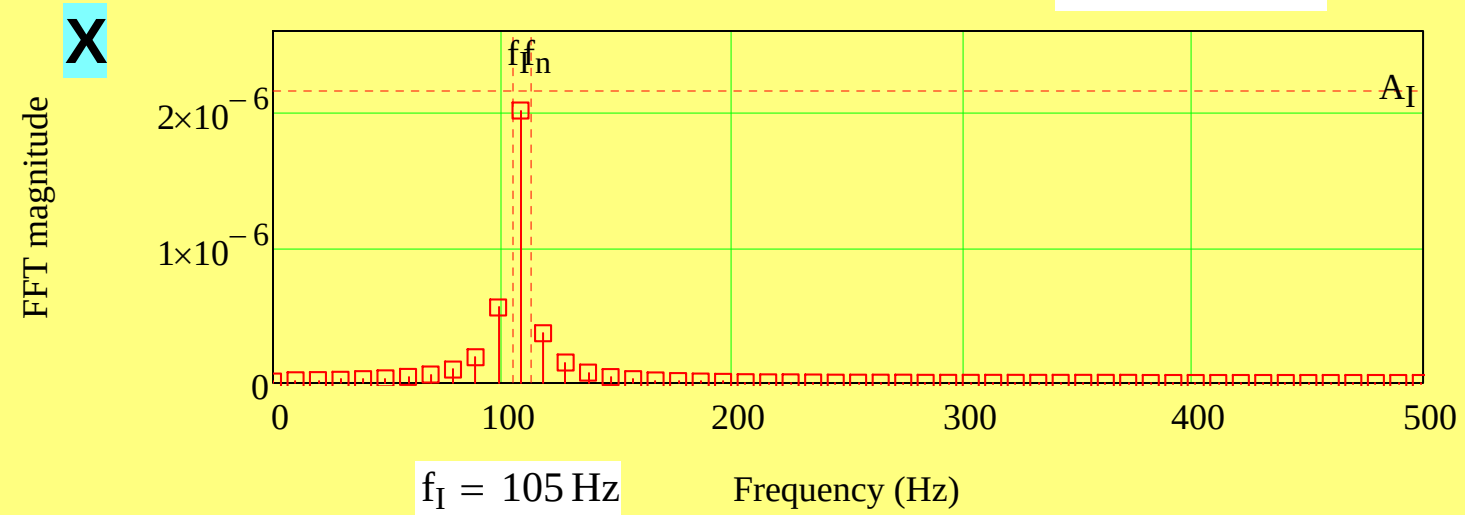
$$A_I := \frac{F_I}{\left|K - M\cdot(\omega_I)^2 + i\cdot C\cdot\omega_I\right|} = 2.162\times10^{-6}\,m$$

exact value

$$A_{max} := \max(A) = 2.008\times10^{-6}\,m$$

$$\frac{A_{max}}{A_I} = 0.929$$

$f_n = 112.54\cdot Hz$



$\Delta f = 9.785\,Hz$

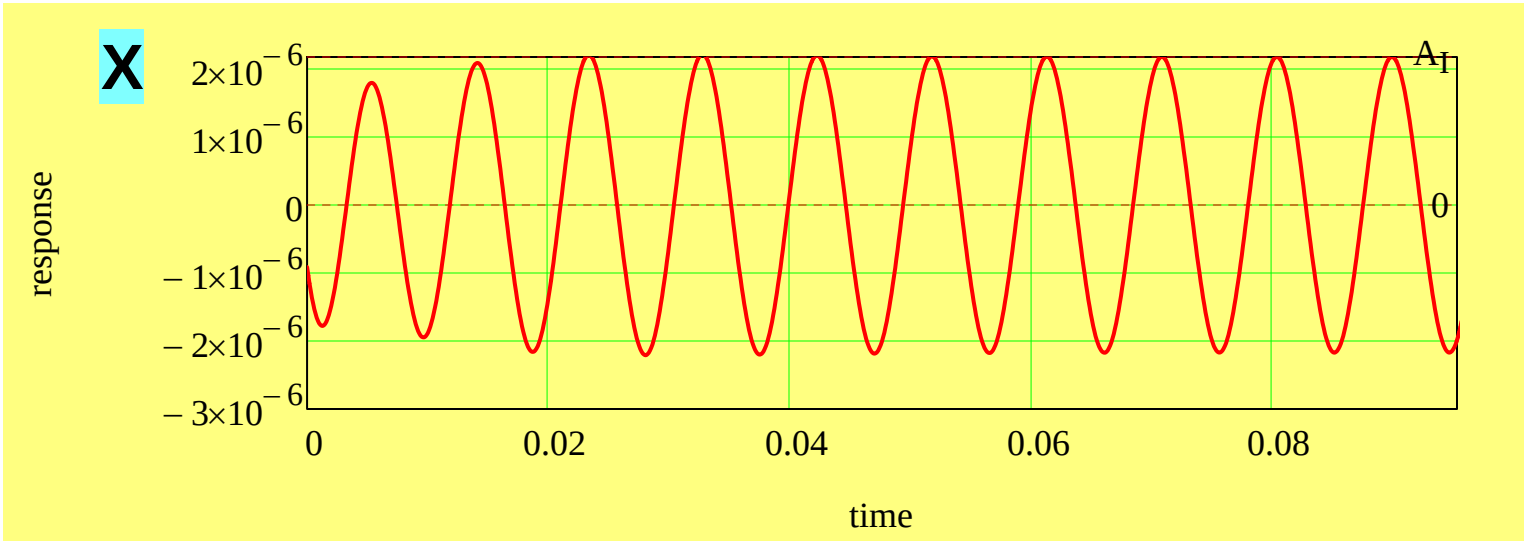
$f_{req_9} = 78.278\,Hz$

f=105 Hz

(b) Time response

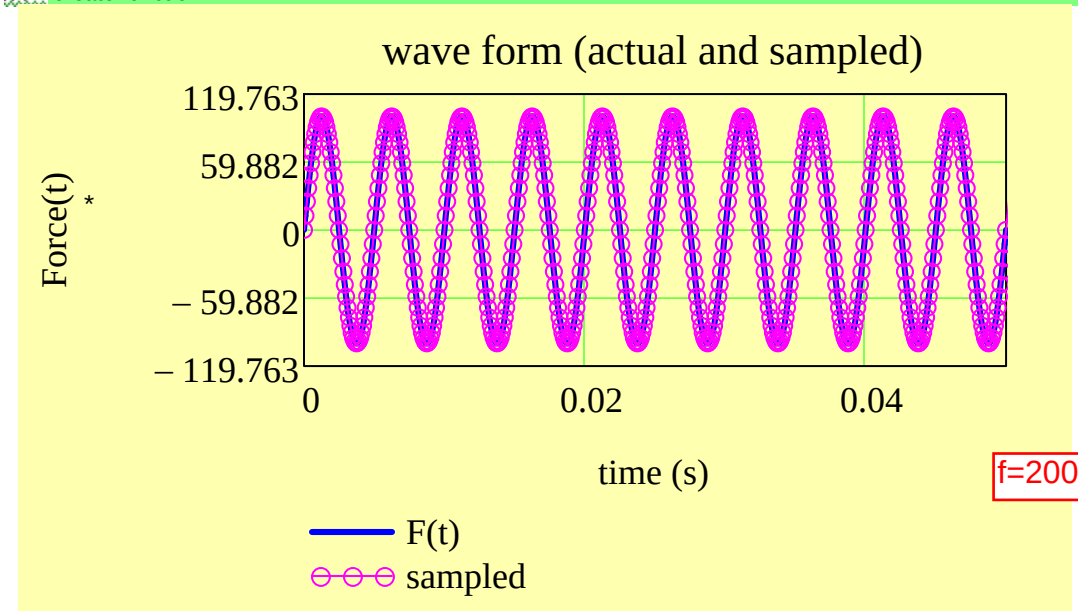
$\max(X) = 2.198 \times 10^{-6}\,\text{m}$

$A_I = 2.162 \times 10^{-6}\,\text{m}$ exact response



f=105 Hz

Create function

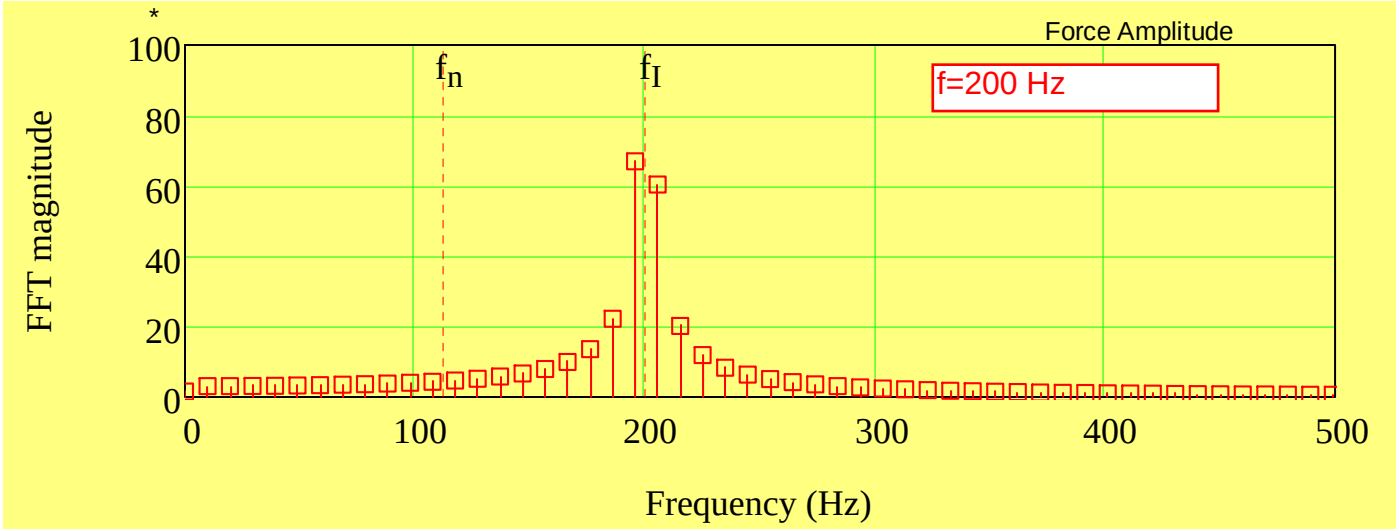


$$\frac{T_{max}}{T_I} = 20.46 \quad \text{cycles}$$

$$\frac{\Delta t}{T_I} = 0.02$$

$FI_{max} := F_I$

Create FFT



$\Delta f = 9.785 \cdot Hz$

$T_{max} = 0.102\ s$

$f_{max} = 5 \times 10^3 \cdot Hz$

$$\frac{f_{max}}{\Delta f} = 511$$

R & I parts of FX

Build system response (frequency and time)

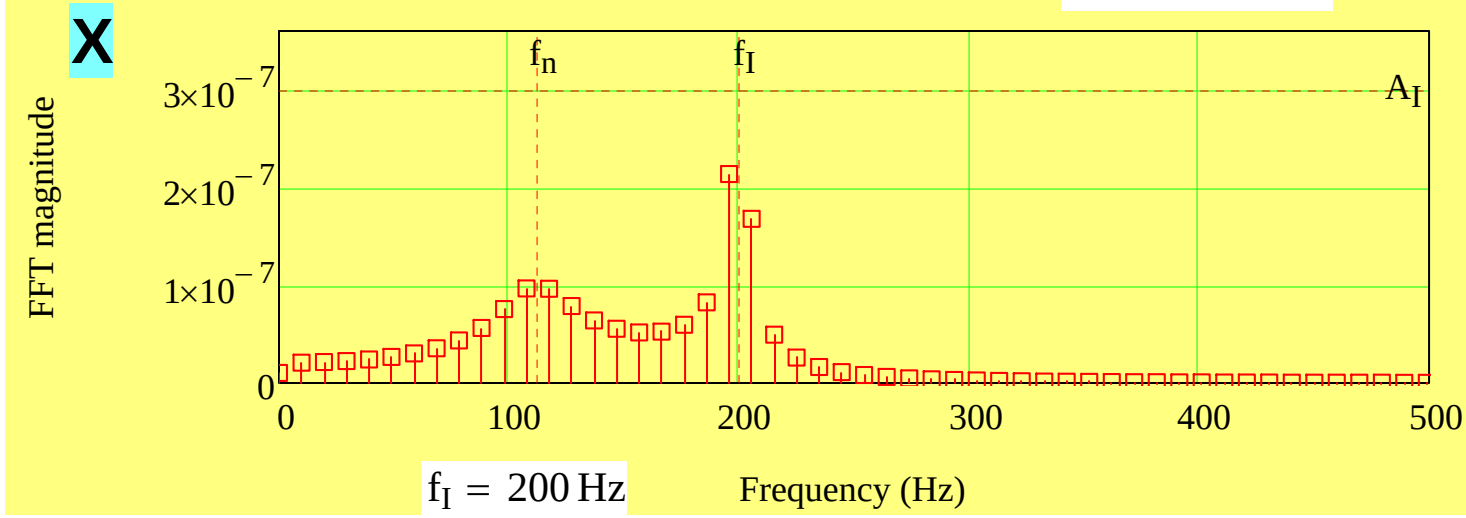
$$A_I := \frac{F_I}{\left|K - M\cdot(\omega_I)^2 + i\cdot C\cdot\omega_I\right|} = 2.999\times10^{-7}\,m$$

exact value

$$A_{max} := \max(A) = 2.136\times10^{-7}\,m$$

$$\frac{A_{max}}{A_I} = 0.712$$

$f_n = 112.54\cdot Hz$



$f_I = 200\,Hz$

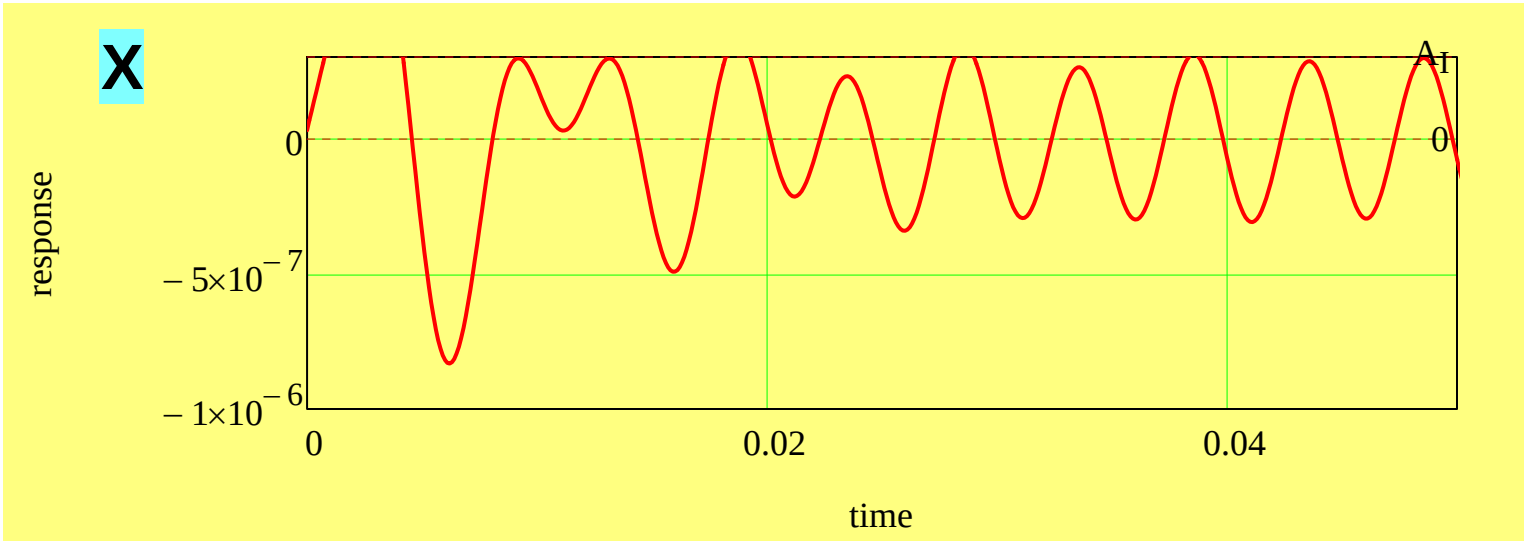
$\Delta f = 9.785\,Hz$

$f_{req_9} = 78.278\,Hz$

(b) Time response

$\max(X) = 8.743 \times 10^{-7}\,\text{m}$

$A_I = 2.999 \times 10^{-7}\,\text{m}$ exact response



f=200 Hz