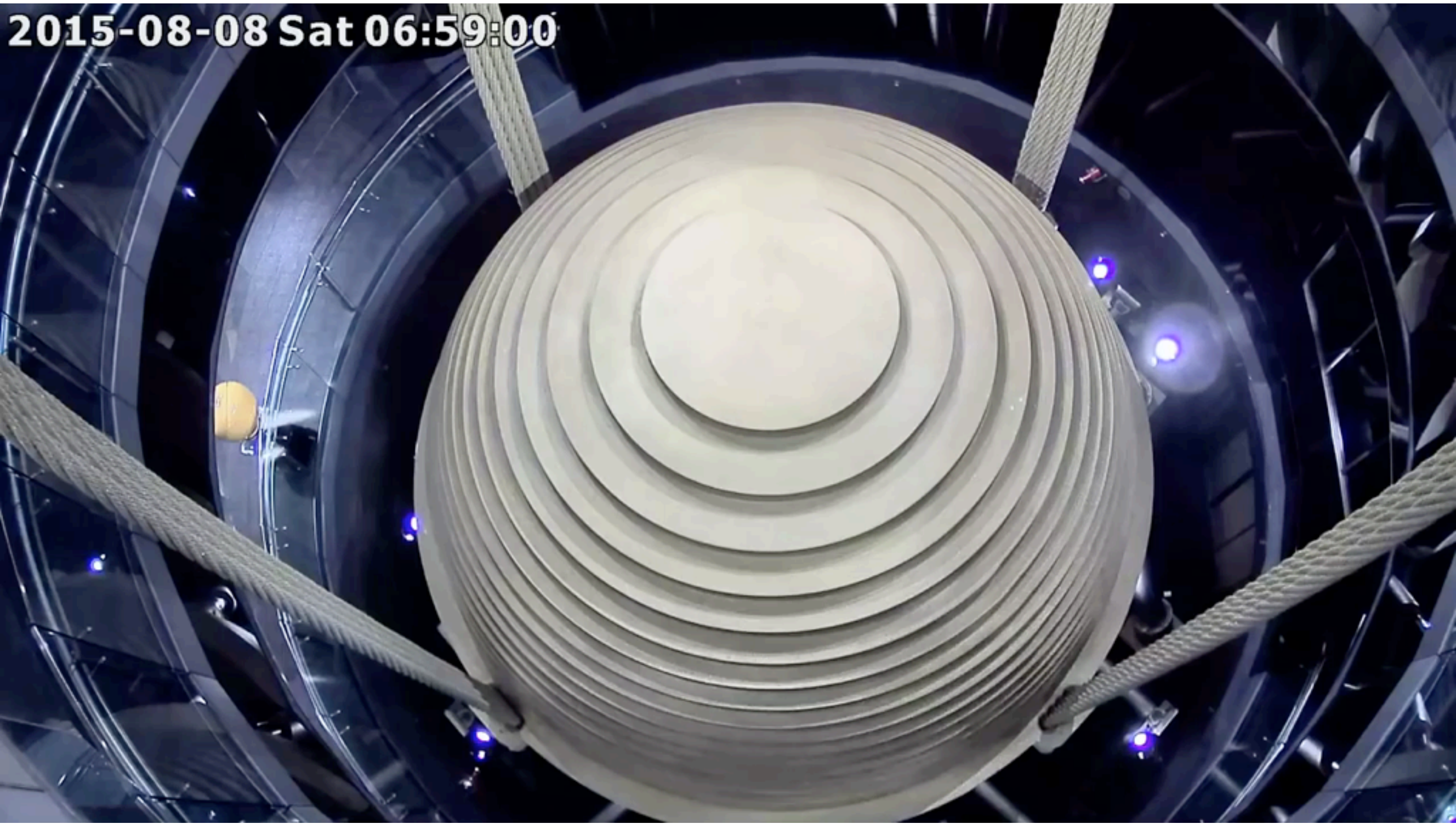
18.031

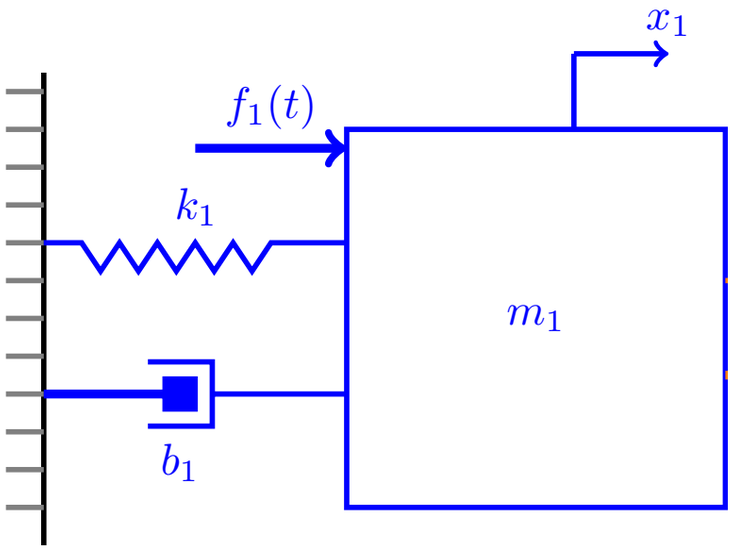
Day 8

Tuned mass damper



https://www.youtube.com/watch?v=xqELmBNyWfU

Mass 1 alone

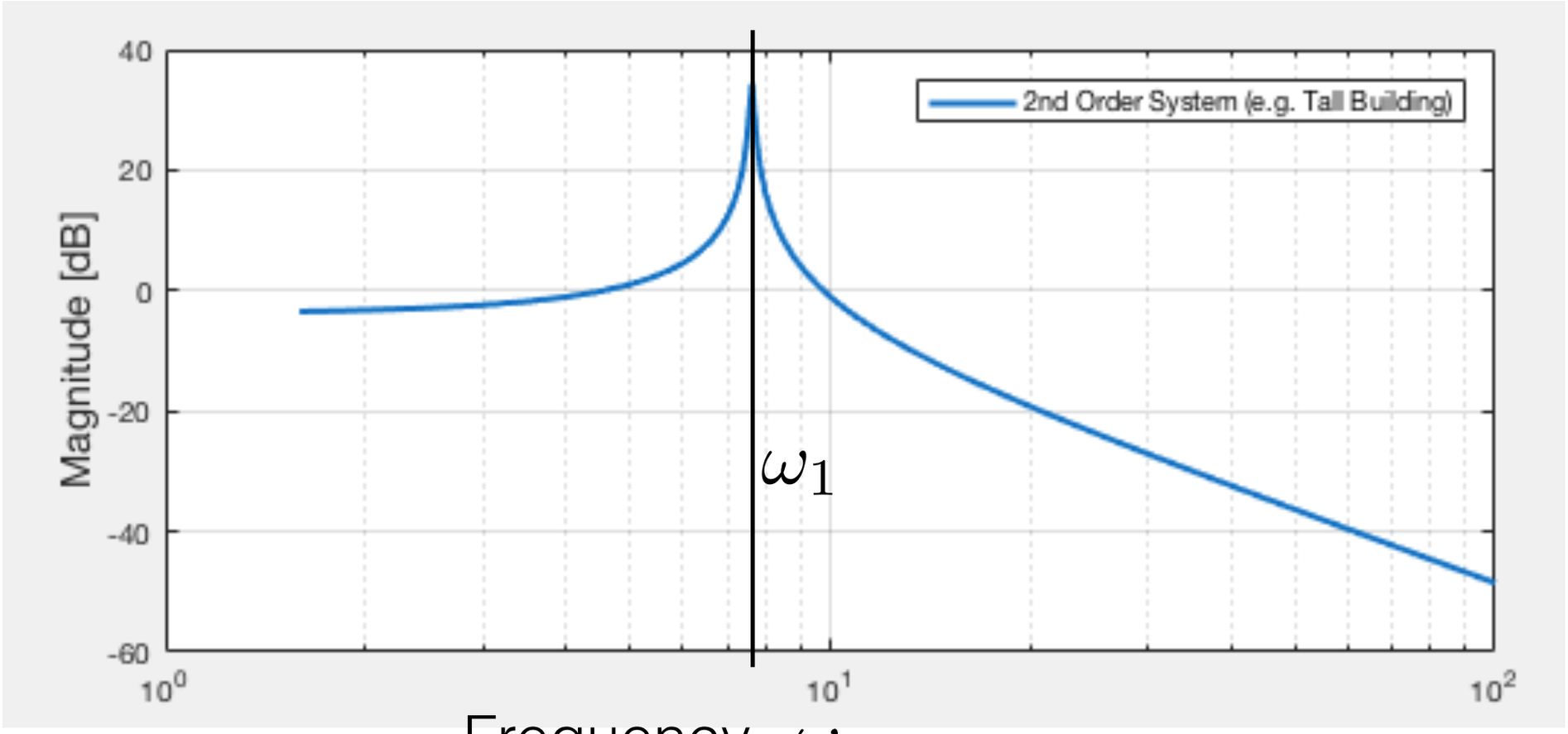


$$m\ddot{x}_1 + b_1\dot{x}_1 + k_1 x_1 = f_1(t)$$

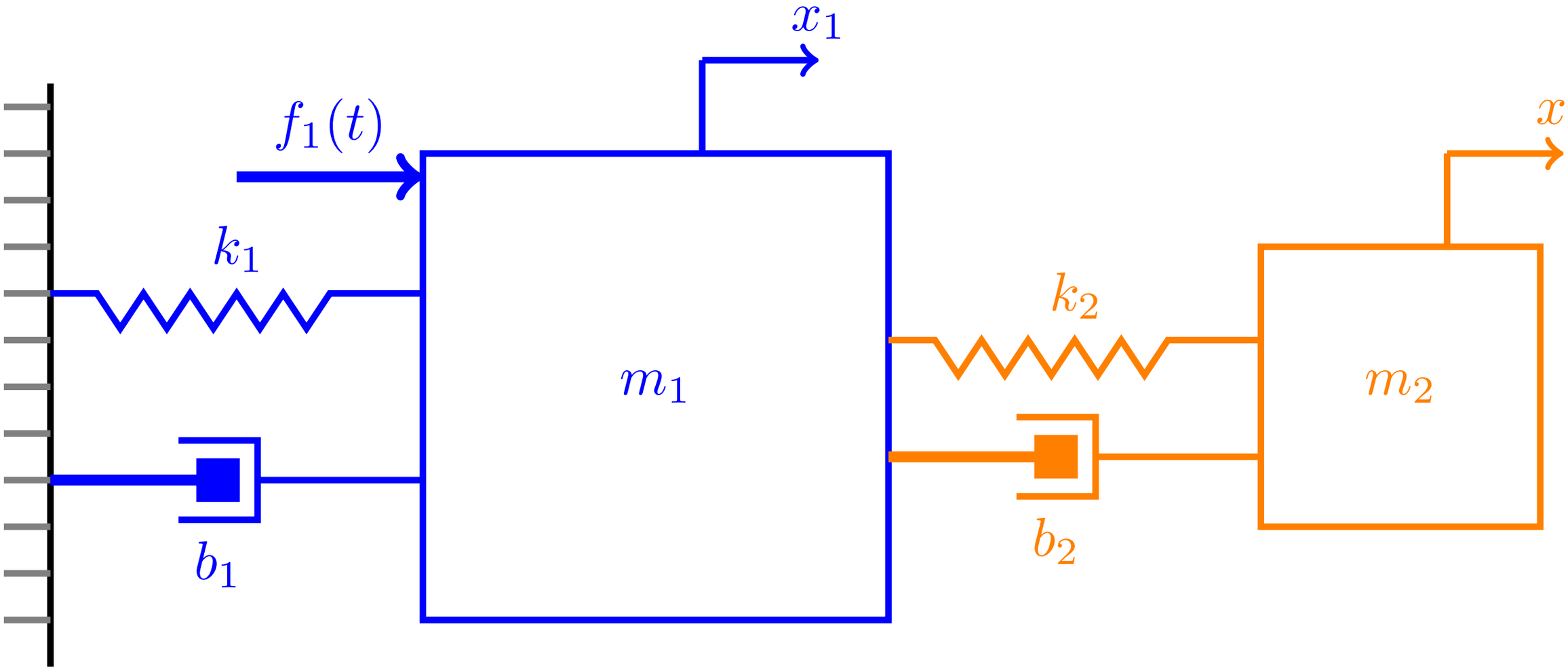
$$H(s) = \frac{1}{ms^2 + b_1 s + k_1}$$

$|H(i\omega)|$

(gain)

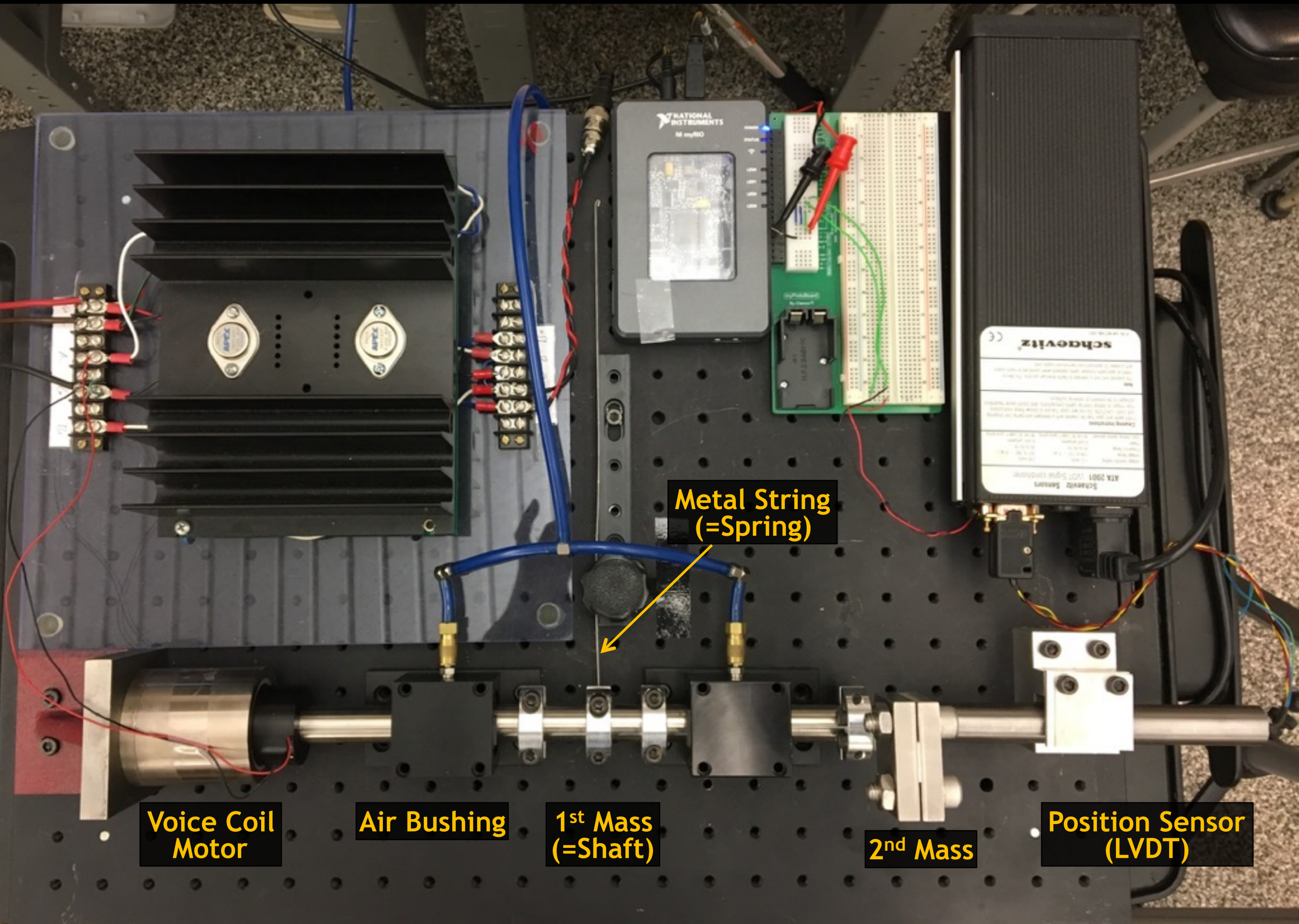


Tuned mass damper



effective way to remove resonance of first mass m1

by Jun Young Yoon



Time Response | DSA

Cycle Specs

Cycles To Settle (M): 10
Cycles To Calculate (N): 10

DSA?

START

STOP

Excitation Specs

Excitation Frequencies

Initial Frequency: 2
Final Frequency: 100
Frequency Units: [Hz]
Number of Frequencies: 40
Samping Time [s]: 0.001

Excitation Magnitude

Amplitude [V]: 0.8
Offset [V]: 0
[rad/s]

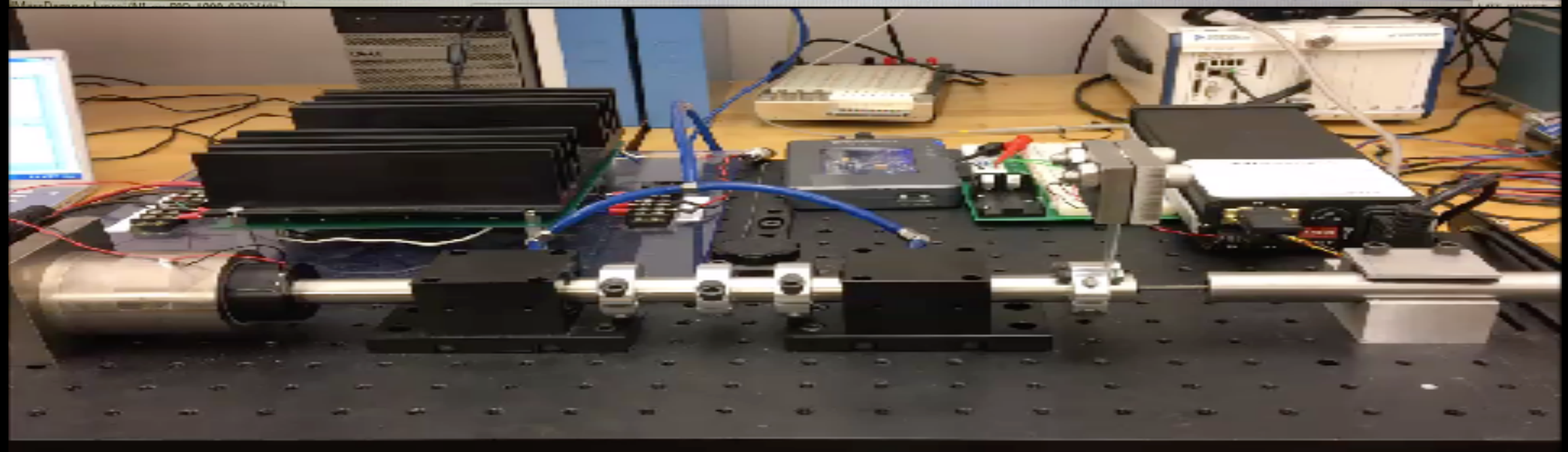
Response | Stimulus

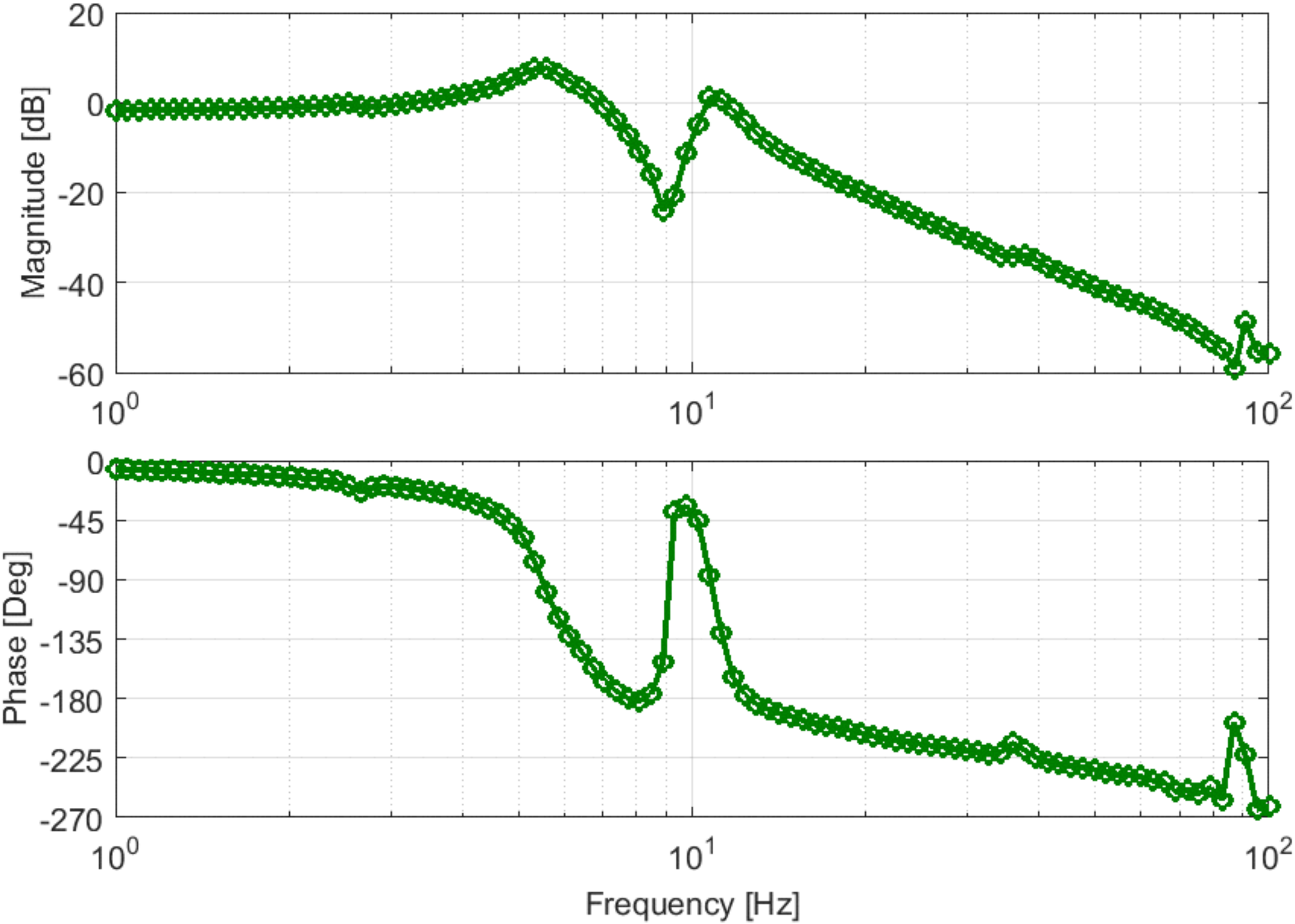
Amplitude
0.07
0.065
0.06
0.055
0.05
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
55339
56338
Time

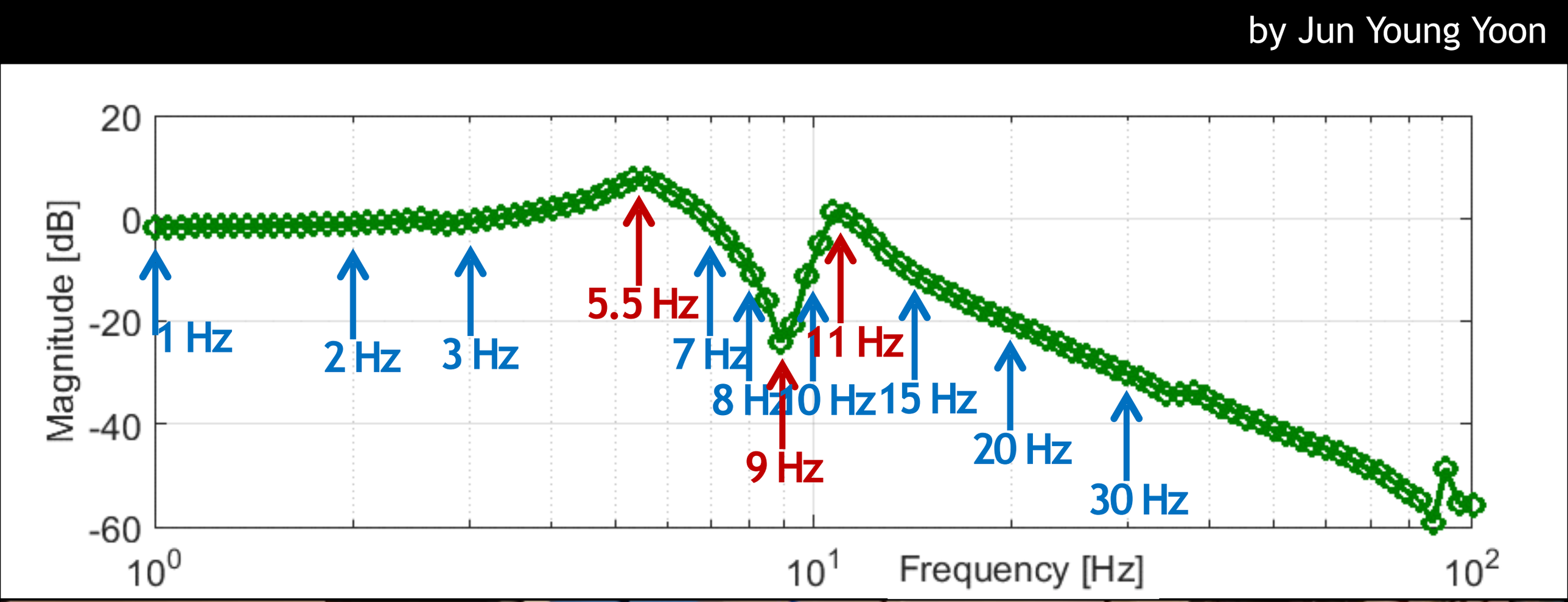
Magnitude (abs)
10
1
0.1
0.01
1
10
100
1000
Frequency (Hz)

Phase (deg)
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
1
10
100
1000
Frequency (Hz)

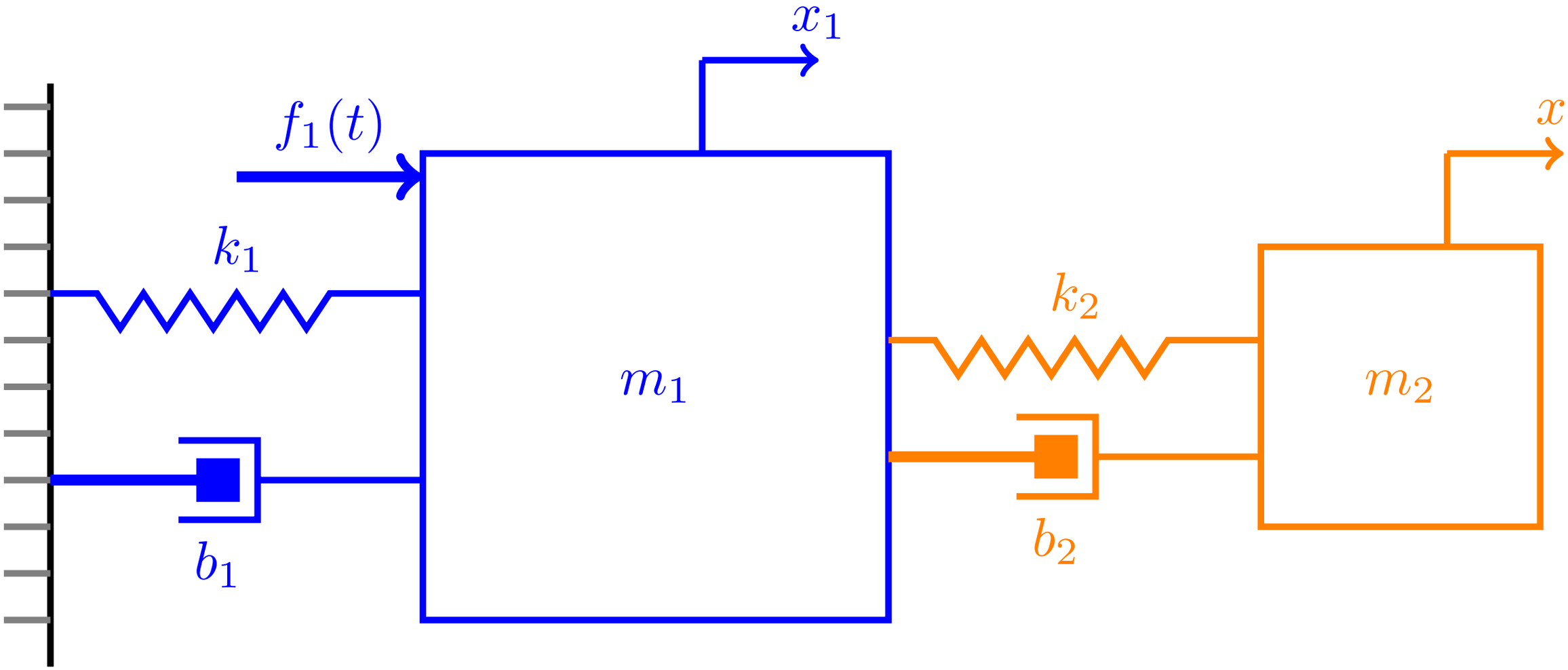
Tab Control




Magnitude [dB]
20
0
-20
-40
-60
10^0
10^1
10^2
Phase [Deg]
0
-45
-90
-135
-180
-225
-270
10^0
10^1
10^2
Frequency [Hz]


20
0
-20
-40
-60
Magnitude [dB]
10^0
10^1
10^2
Frequency [Hz]
1 Hz
2 Hz
3 Hz
5.5 Hz
7 Hz
8 Hz
9 Hz
10 Hz
11 Hz
15 Hz
20 Hz
30 Hz

Tuned mass damper



Mechanical parameters:

m1 = 0.85	b1 = 14	k1 = 1950
m2 = 0.3	b2 = 0.4	k2 = 947.5

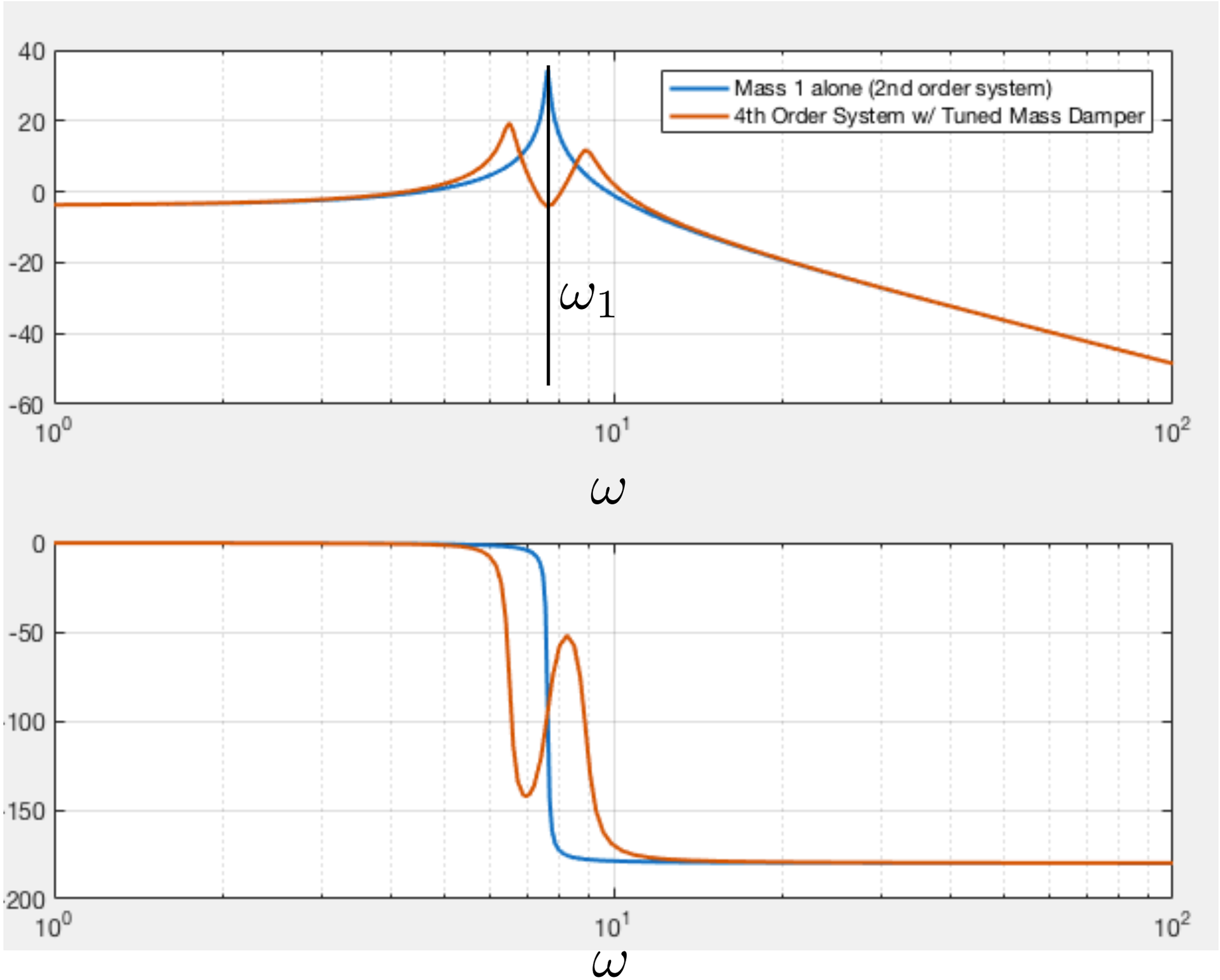
System function for x1

=H(s)

$$X_1 = \frac{P_2}{P_1 P_2 + m_2 s^2 Q_2} F_1$$

$|H(i\omega)|$

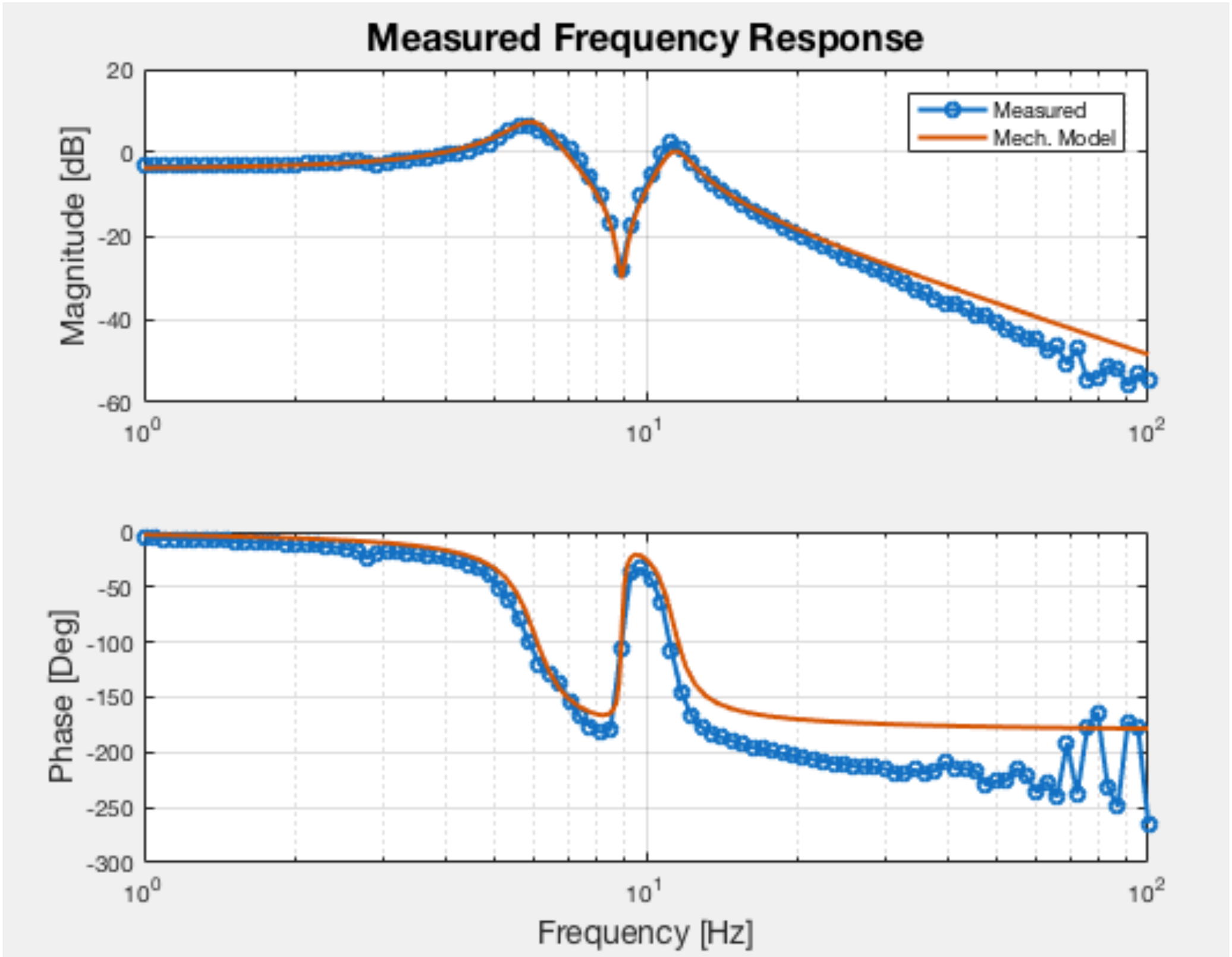
(gain, dB)



$-\phi(i\omega)$

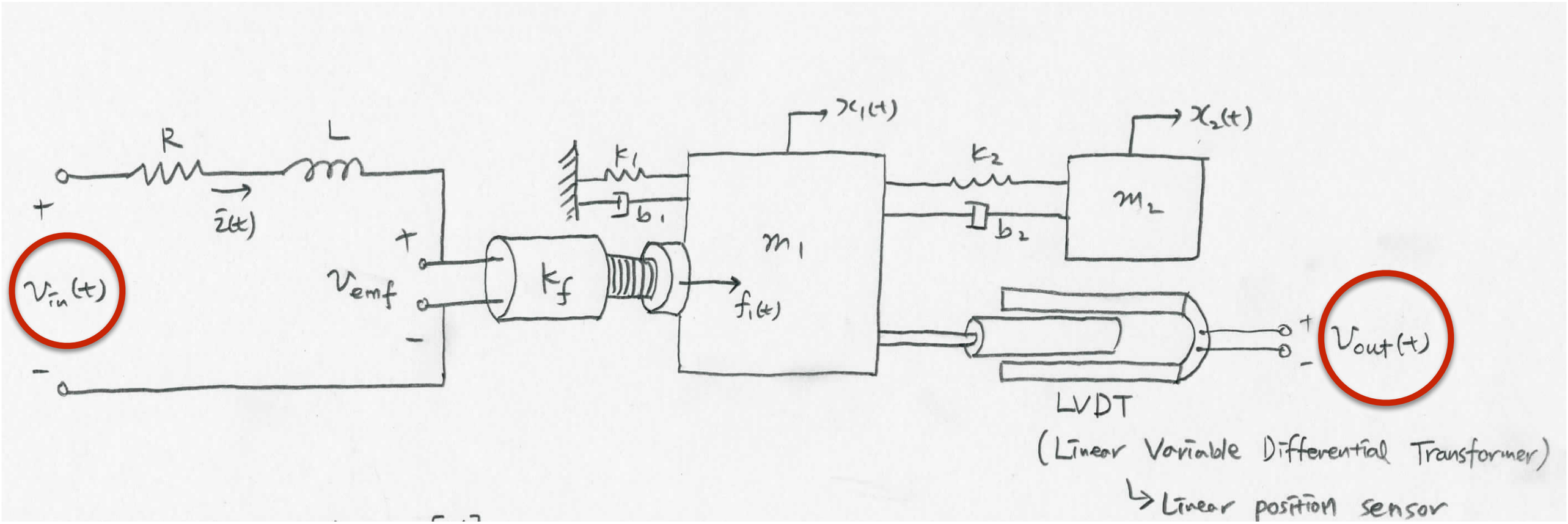
(phase gain)

Comparing with experimental data



Improving the model

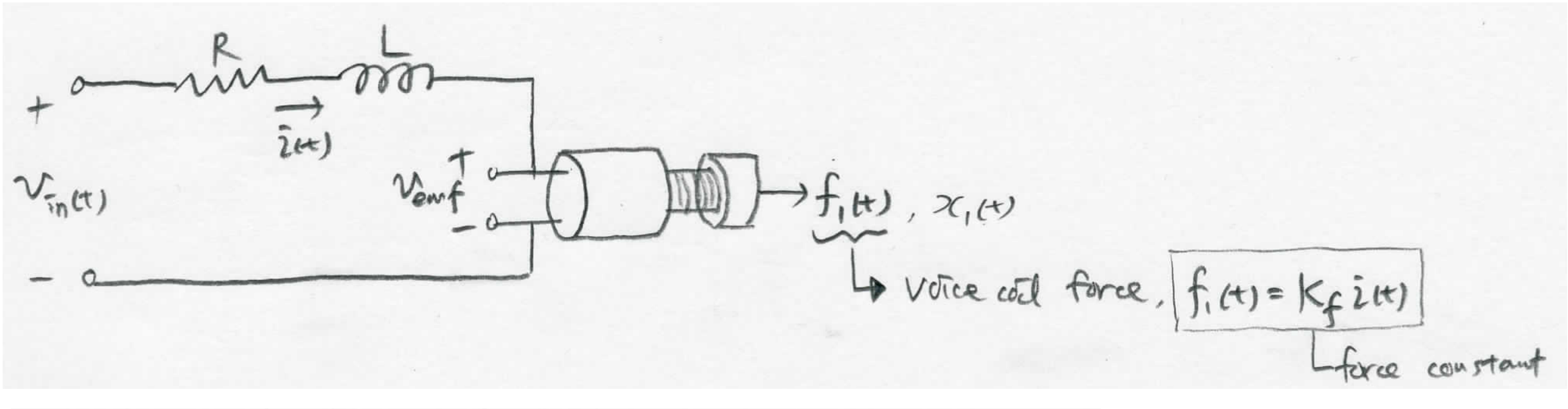
- Take electric circuit driving the system into account:



Experiment: Input is Vin(t), measured output is Vout(t)

External forcing f1 itself is the response of an electric system!

Electric system



- $v_{in}(t)$ = Input voltage [V]
- v_{emf} = Back EMF (Electo-Motive Force) [V]
- R = resistance of voice coil actuator system [Ω]
- L = Inductance " [H]
- k_f = force constant [N/A]

What is system function from Vin(t) to f1(t)?

Electric system

Electrical parameters

$\alpha = 1250$

$R = 1$

$L = 5 \cdot 10^{-3}$

$k_f = 1$