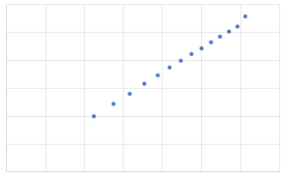


The investigation the effect of spring constant (k) on system's natural frequency (ω) under fixed conditions

1. The objective of this lab is to investigate the effect of spring constant (k) on system's natural frequency (ω) under fixed conditions.
2. The objective functional form of the lab is as shown in the table below.

Objective Statement	Objective Functional Form	Objective Graphical Representation
Investigate the effects of spring constant (k) on system's natural frequency (ω) under fixed conditions	$\omega = f(k; - ; m, A, f, x)$ <p>Where: ω = natural frequency k = spring constant m = mass A = sine wave's amplitude f = sine wave's frequency x = mass's initial position</p>	

3. Experimental conditions and scope

Varied parameter:

$$\text{Spring constant (k): } 20 \leq k \leq 150 \left(\Delta k = 10 \frac{N}{m} \right)$$

Fixed parameters:

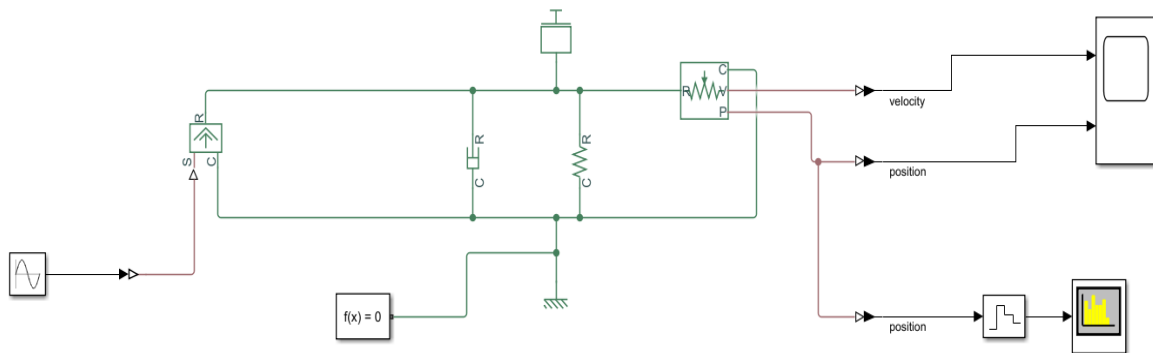
Mass (m): 20 kg

Sine wave's amplitude (A) = 200

Sine wave's frequency (f) = 100 hz

mass's initial position (x) = 0 m

4. To do such task, MATLAB Simulink program is needed to simulation the system of mass-spring damper as shown below.



5. The system consists of sine wave block (used to generate sine wave), ideal force source (used to generate force), spring, damper, ground reference, ideal translational motion sensor, and a

mass. The output of the system are position and velocity of the point mass which are monitored by scope.

6. The setting of the initial system is as followed: Sine wave (amplitude of 500, frequency of $100 \frac{\text{rad}}{\text{s}}$), damping coefficient of $0 \frac{\text{N}}{\text{m/s}}$, spring constant of $20 \frac{\text{N}}{\text{m}}$, and initial position of 0 m .



Block Parameters: Sine Wave

Sine Wave

Output a sine wave:

$$O(t) = \text{Amp} * \sin(\text{Freq} * t + \text{Phase}) + \text{Bias}$$

Sine type determines the computational technique used. The parameters in the two types are related through:

Samples per period = $2 * \pi / (\text{Frequency} * \text{Sample time})$

Number of offset samples = $\text{Phase} * \text{Samples per period} / (2 * \pi)$

Use the sample-based sine type if numerical problems due to running for large times (e.g. overflow in absolute time) occur.

Parameters

Sine type: Time based

Time (t): Use simulation time

Amplitude: 500

Bias: 0

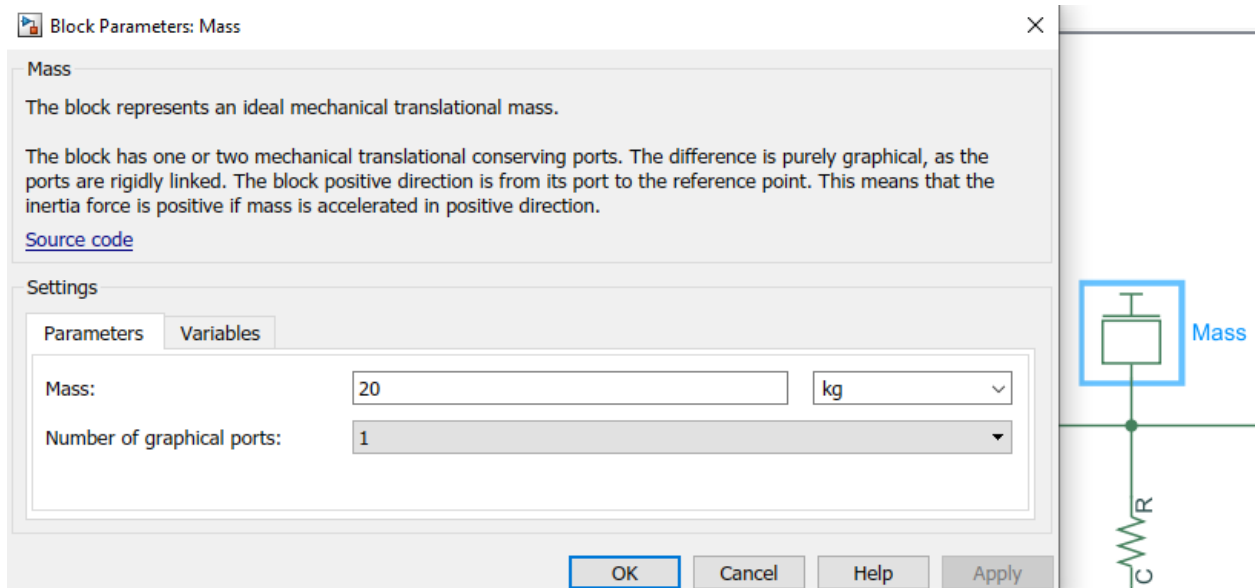
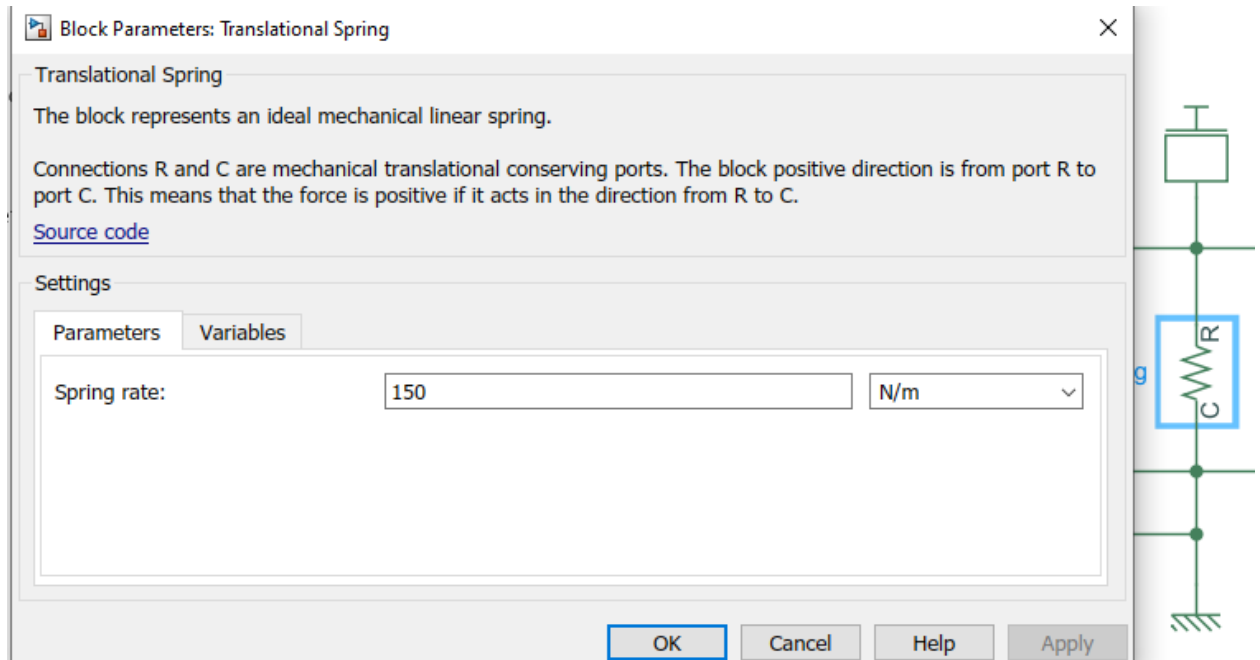
Frequency (rad/sec): 100

Phase (rad): 0

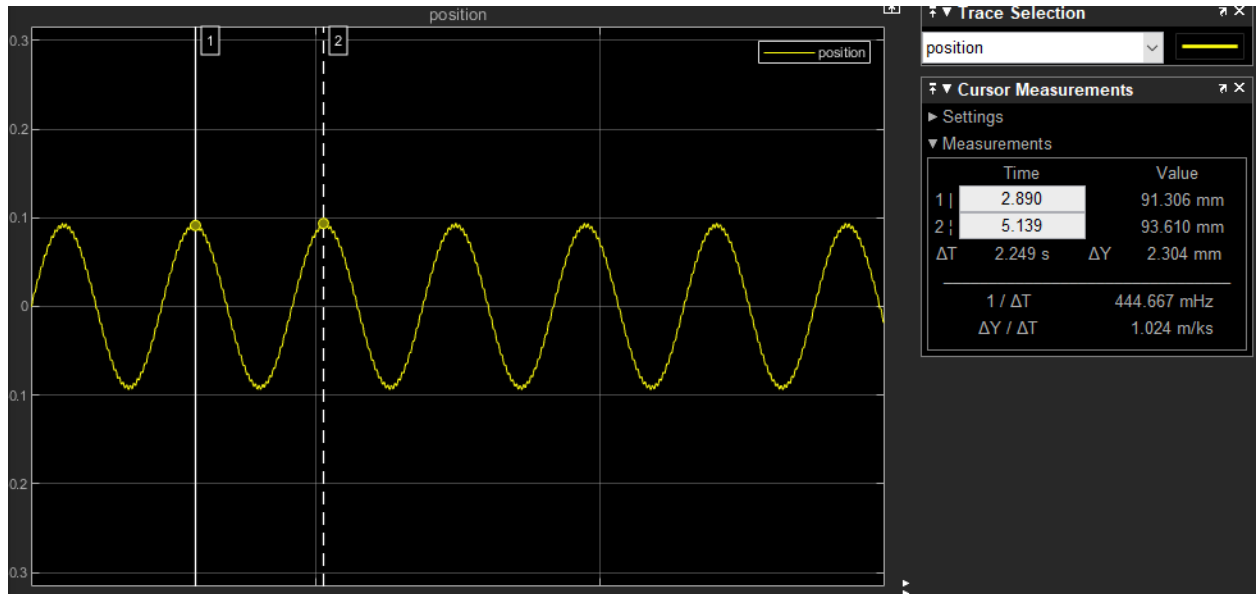
Sample time: 0

☒ Interpret vector parameters as 1-D

OK Cancel Help Apply



7. In scope, the graph can be seen in the figure below.



8. The different in time between peaks can be determined from the graph using cursor measurements tool.
9. Then, the spring constant (k) is varied from 20 to 150 $\frac{N}{m}$.
10. The data is then processed in Excel as shown in table below.

mass	20 kg	hz to rad/s	6.283185		
sine wave frequency		100 rad/s			
k	sqrt(k)	delta T (s)	freq (hz)	scope freq (rad/s)	cal nat freq (rad/s)
20	4.472	6.297	0.159	0.998	1.000
30	5.477	5.127	0.195	1.226	1.225
40	6.325	4.475	0.223	1.404	1.414
50	7.071	3.958	0.253	1.587	1.581
60	7.746	3.621	0.276	1.735	1.732
70	8.367	3.351	0.298	1.875	1.871
80	8.944	3.148	0.318	1.996	2.000
90	9.487	2.969	0.337	2.116	2.121
100	10.000	2.834	0.353	2.217	2.236
110	10.488	2.699	0.371	2.328	2.345
120	10.954	2.586	0.387	2.430	2.449
130	11.402	2.496	0.401	2.517	2.550
140	11.832	2.406	0.416	2.611	2.646
150	12.247	2.249	0.445	2.794	2.739

Where the calculated natural frequency is determined using the equation below.

$$\omega = \sqrt{\frac{k}{m}}$$