バネ振動の変位の計算

要約

SmallBasic

gnuplot sin

I researched about antivibration rubber in order to learn how it absorbs energy when an earthquake happens. The motion of antivibration rubber is very complicated, so I replaced the antivibration rubber with spring and did a simulation. The First, using the software “Small basic”, we calculated the displacement of the spring as motion. Next, using the software “Gnuplot”, we plotted its sin curve to show the shape of quaking. From our results, we were able to calculate a formula for displacement when a quake occurs. This formula is based on spring displacement, so for further study, we want work out a formula for the rubber. Therefore we want to study what conditions are needed in addition to the past condition to measure the rubber’s movement.

キーワード Small Basic gnuplot sin

simulation, Small Basic, gnuplot, sin curve, antivibration rubber ,earthquake

１.序論

Smallbasic

（１）バネ振動の変位の式を作成

($F = -kx$) ($F = ma$) $ma = -kx$

（２）式の中の微分を差分法を用いて表す

２.研究方法

n

x_n x_{n-1} x_n

$\boldsymbol{v_n}$ x_n x_{n+1}

$\boldsymbol{v_{n+1}}$

SmallBasic Δt v_n v_{n+1} $\boldsymbol{v_n} = \frac{x_n - x_{n-1}}{\Delta t}$

Smallbasic gnuplot $\boldsymbol{v_{n+1}} = \frac{x_{n+1} - x_n}{\Delta t}$

a

$v_{n+1}-v_n$ Δt

$a=(\boldsymbol{v_{n+1}}-\boldsymbol{v_n})/\Delta t$

$=\left(\frac{x_{n+1}-x_n}{\Delta t}-\frac{x_n-x_{n-1}}{\Delta t}\right)/\Delta t$

$=(x_{n+1}-x_n-x_n+x_{n-1})/\Delta t^2$

$ma=-kx$

$a=(x_{n+1}-x_n-x_n+x_{n-1})/\Delta t^2=-\frac{k}{m}x_n$

$(x_{n+1}-2x_n+x_{n-1})=-\frac{k}{m}x_n\Delta t^2$

$x_{n+1}=2x_n-\frac{k}{m}x_n\Delta t^2-x_{n-1}$

$=(2-\frac{k}{m}\Delta t^2)\ x_n-x_{n-1}$

$x_{n+1}=(2-K\Delta t^2)\ x_n-x_{n-1}\ (K=\frac{k}{m}$) …

x_{n+1} x_n

x_{n-1}

x2

x_{n+1} x2 x_n x1 x_{n-1} x0

x2=1.2*x1-x0

1.2

x1 = x0

X2 = x1

x1 x0 x2

x1

EndWhile

1

0 1

（３）できた式を用いて Smallbasic で計算，gnuplot でグラフを作成する

1 =1, m=1 1 Δt = 0.1 2

gnuplot

```
x0 = -1
x1 = 1
While (x2 < 2.4)

TextWindow.WriteLine(x2)
x2=1.2*x1-x0
x1 =x0
x2=x1
EndWhile
```

Smallbasic

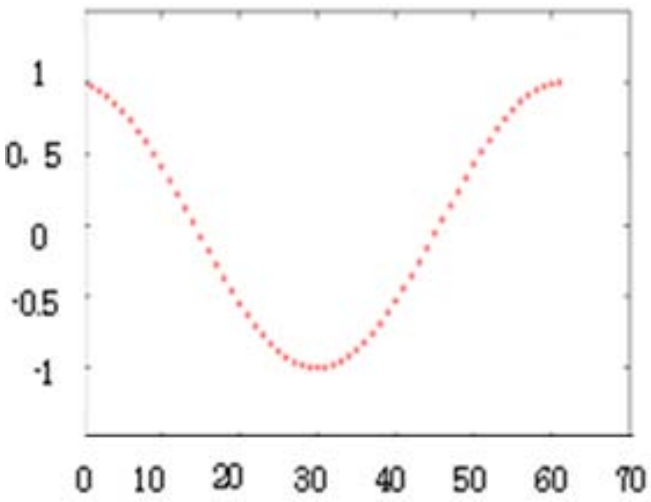
x0 = -1 x0 -1

x1 = 1 x1 1

While (x2 < 2.4) x2 2.4 x0

x1

TextWindow.WriteLine(x2)



1. 2

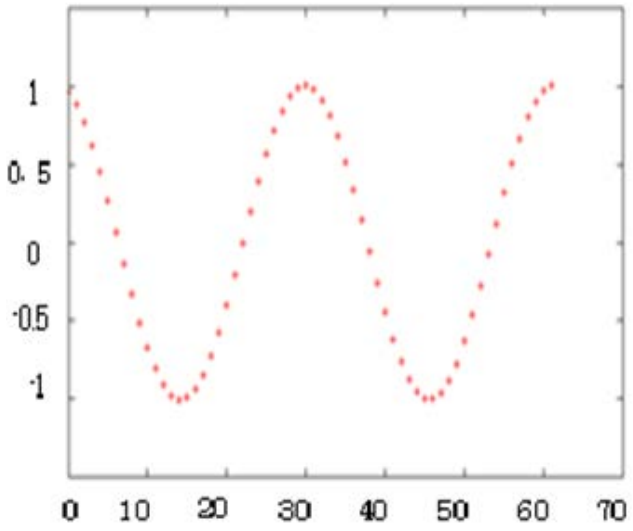
sin

2 $k = 2$

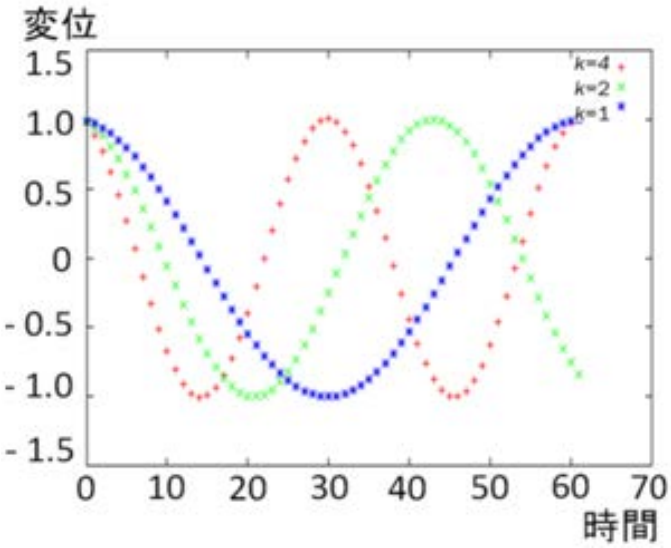
T k

T $T = 2\pi\sqrt{\frac{m}{k}}$

T k



2. 3



4. $k = 1, 2, 4$

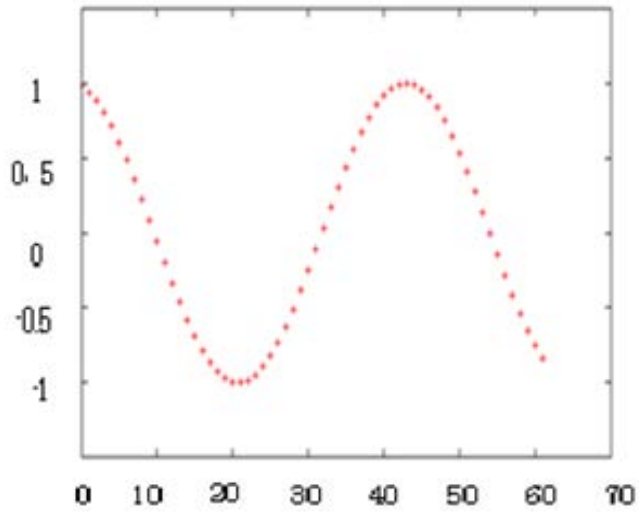
2 2 4

3

smallbasic

,

2, 3, 4



3. 4

3

sin

```
GraphicsWindow.Width = 800
GraphicsWindow.Height = 800
GraphicsWindow.BackgroundColor = "Black"
cx = 400
cy = 400

GraphicsWindow.Show()
n=0
x0 = 1
x1 = 1
k=2
m=1
dt=0.1
t=0
nt=620
While (n < nt)
  TextWindow.WriteLine(x2)
  TextWindow.WriteLine(n)
  n=n+1
  t=n*dt
  x2=(2-k/m*dt*dt)*x1-x0
  x0=x1
  x1=x2
  Program.Delay(50)
  GraphicsWindow.BrushColor = "White"
    GraphicsWindow.FillRectangle(cx, cy+x2*100, 10, 10)

    Program.Delay(10)
    GraphicsWindow.BrushColor = "Black"
    GraphicsWindow.FillRectangle(cx, cy+x2*100, 10, 10)
  File.WriteLine("bane4.txt",n,x2)
EndWhile
```

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5.

3. 結果

4. 考察

k

$$T = 2\pi\sqrt{\frac{m}{k}}$$

5. 今後の課題

6. 謝辞