MATLAB Assignment 1

Submitted by
Subhang Vempati

Question1:

Task1&2:

TASK 1:-

$$V_{in} - V_{out} = \frac{dV}{dt}$$

$$V_{in} - \sqrt{2gh}\cdot A_R = \frac{1}{3}\frac{d}{dt}\, hA.$$

$$V_{in} - \sqrt{2gh}\cdot A_R = \frac{\pi}{3}\frac{d}{dt}h\cdot h^2\tan^2\left(\frac{\alpha}{2}\right).$$

$$V_{in} - \sqrt{2gh}\, A_R = \frac{\pi}{3}\frac{d h^3}{dt}\tan^2\left(\frac{\alpha}{2}\right).$$

$$V_{in} - \sqrt{2gh}\, AR = \frac{\pi}{\cancel{3}}\cancel{3}h^2\tan^2\left(\frac{\alpha}{2}\right)\frac{dh}{dt}$$

$$V_{in} - \sqrt{2gh}\, A_R = \pi h^2 \tan^2\frac{\alpha}{2}\,\frac{dh}{dt}$$

$$\boxed{\frac{V_{in} - \sqrt{2gh}\, A_R}{h^2\pi\tan^2\frac{\alpha}{2}} = \frac{dh}{dt}}$$

TASK-2

$$V_{in} - \sqrt{2gh}\, A_R = 0$$

$$V_{in} = \sqrt{2gh}\, A_R.$$

$$\frac{20}{3600} = \sqrt{2gh}\cdot\frac{12\times 1\cancel{0}^{4}}{1000\cancel{0}}$$

$$\frac{\overset{10}{\cancel{20}}\times 100}{\underset{18}{\cancel{36}}\times 12} = \sqrt{2gh}$$

As it is 1% equilibrium.

$$= \frac{1000}{216} = \sqrt{2gh}.$$

$$\Rightarrow \frac{1}{100}\times 1.0924$$

$$= 0.010924$$

$$= \left(\frac{1000}{216}\right)^2 = 2gh.$$

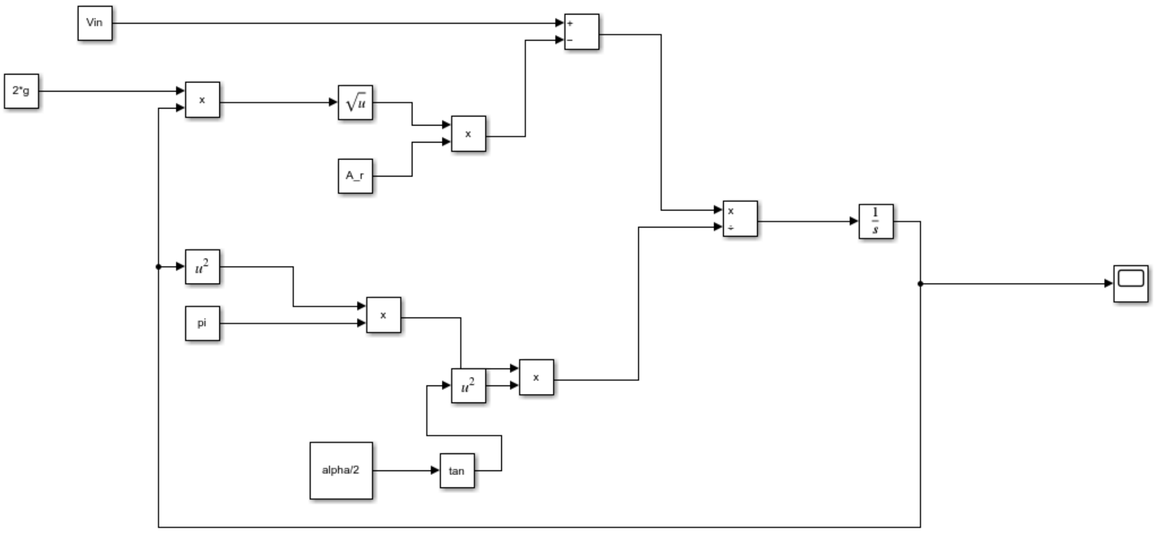
$$\left(\frac{1000}{216}\right)^2 = 19.62\, h =$$

$$h = 1.0924\,m$$

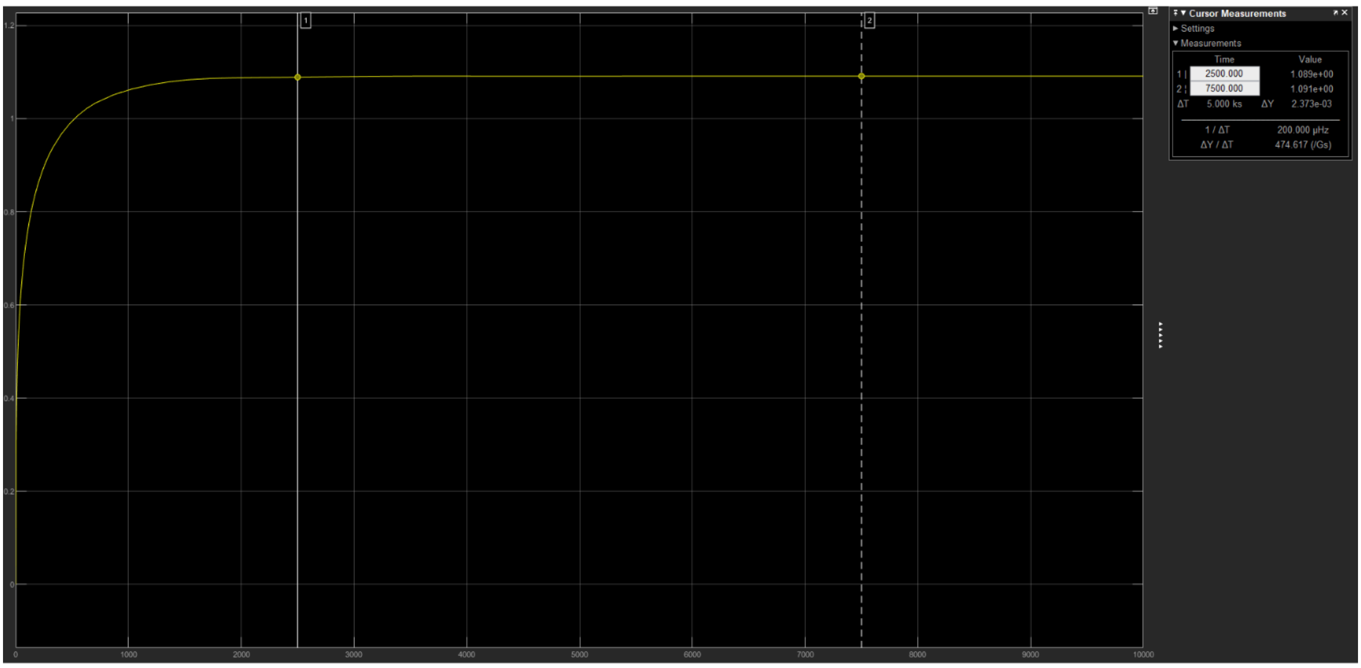
$$1.0924 - 0.010924 = \underline{1.0816}$$

In task 1 of exercise 1 we need produce a differential equation using the given data which must be in the form of h(t) which is a function of time. Then in task 2 we initialized (dh/dt) as zero and found the height of the whole conical tank. I achieved it in the above manner.

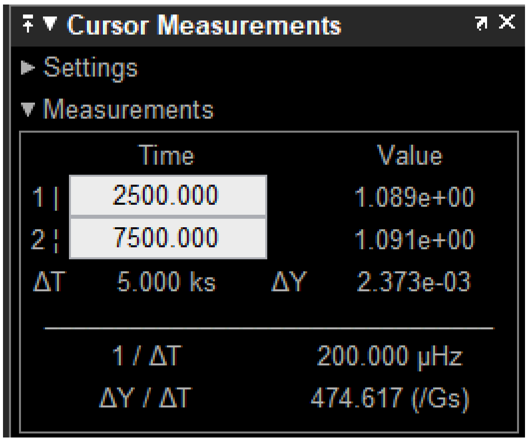
Task 3:



100%

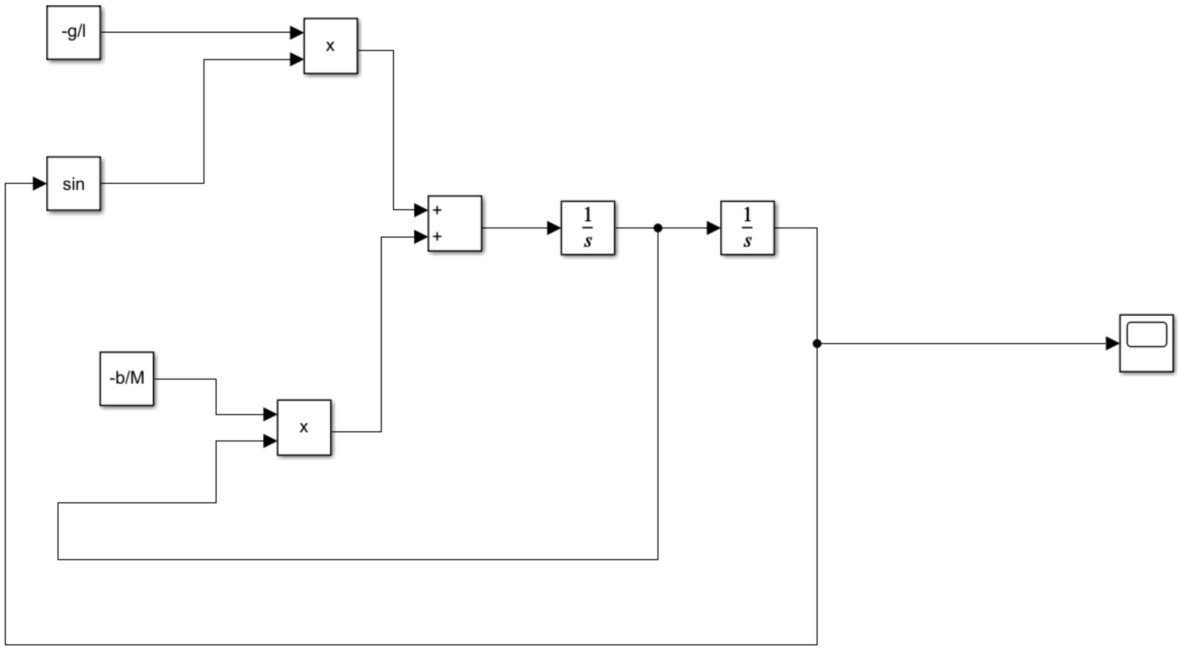


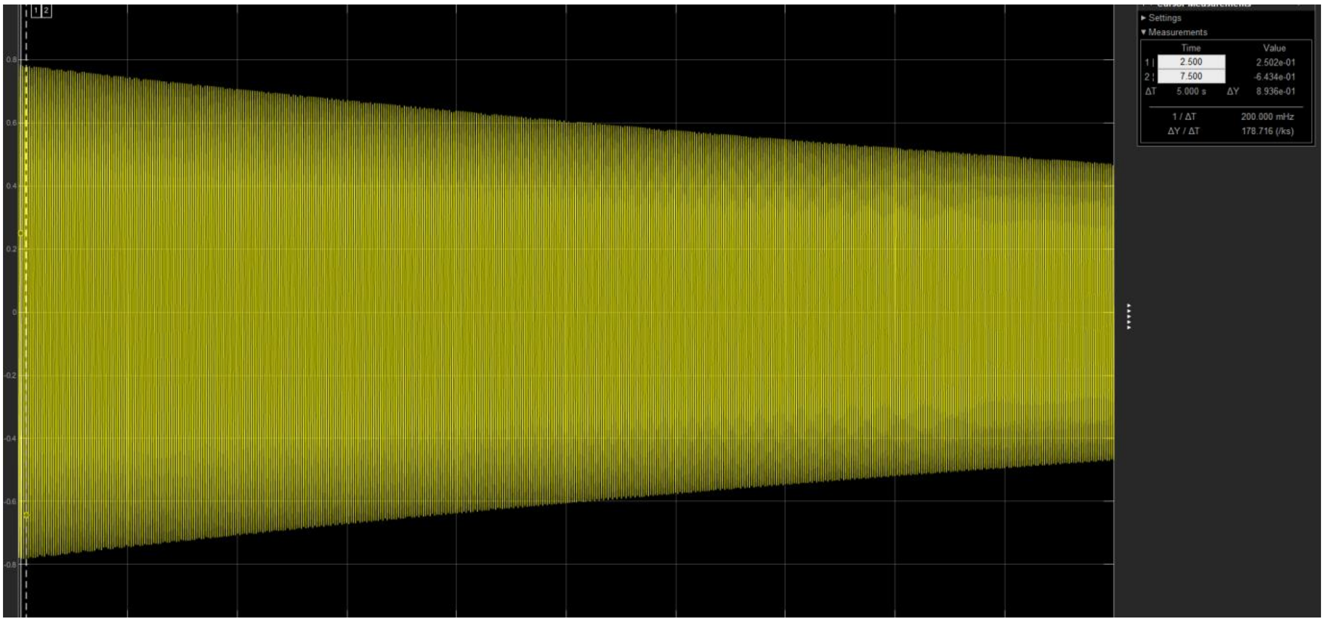
In task 3 we need to find a point where the liquid in the tank reaches 1% equilibrium. I tried to calculate 1% of height of the tank and subtracted it from total height of the tank to know at what point it might reach the equilibrium and cross verified using the value where the plot initially approached its equilibrium. I achieved an equilibrium at a height of 1.089 and the value which I calculated if 1.0816. so that’s confirm at what value it reached 1% equilibrium and modelled according to the specifications. It reached 1% equilibrium at the time of 2500 secs that is 41minutes and 6 secs approximately.



Question 2:

Task 1:





Task 1 is to model a differential equation which is mentioned in the given problem. I have designed the model according to the differential equation. Which is

Exercise 2:-

$$Ml\ddot{\theta} = -Mg\sin\theta - bl\dot{\theta}$$

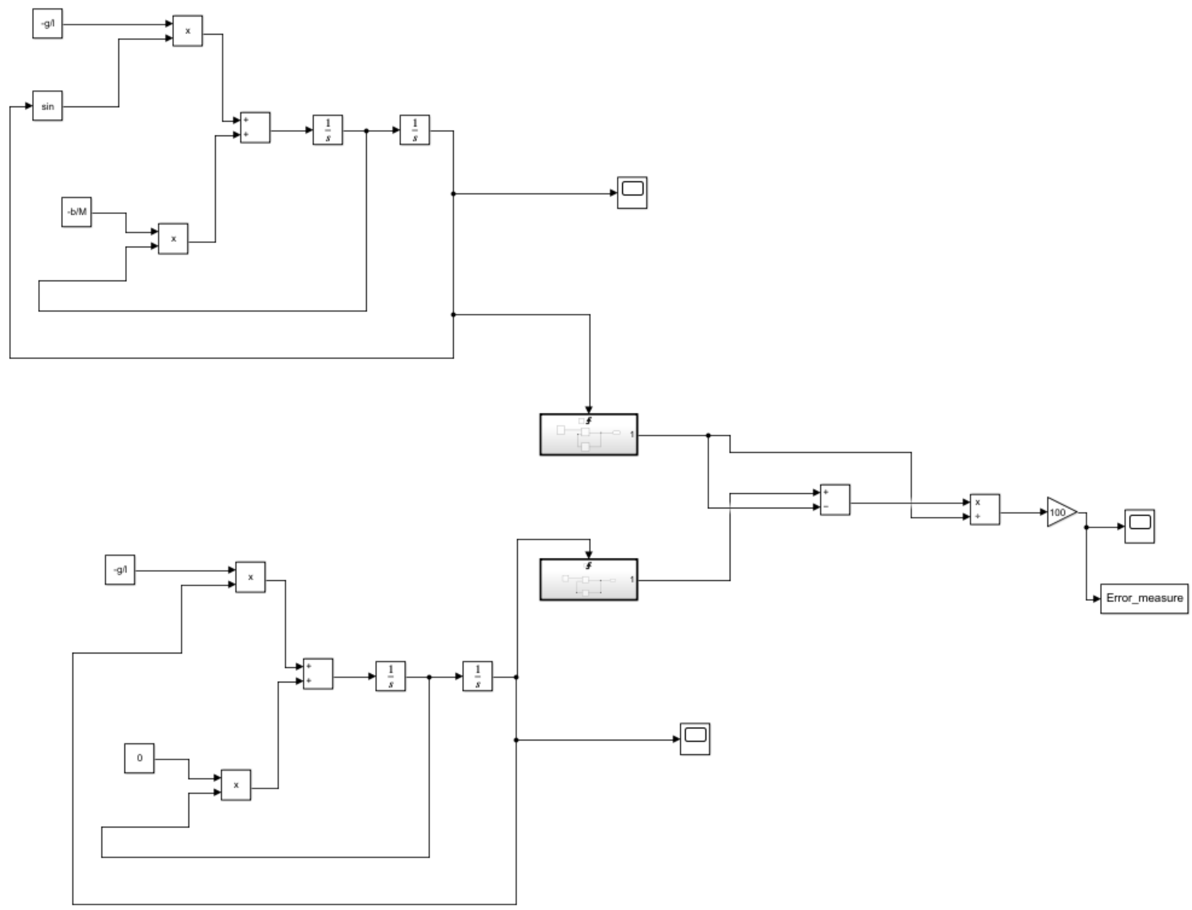
$$\ddot{\theta} = -\frac{\cancel{M}g}{\cancel{M}l}\sin\theta - \frac{b\cancel{l}}{M\cancel{l}}\dot{\theta}$$

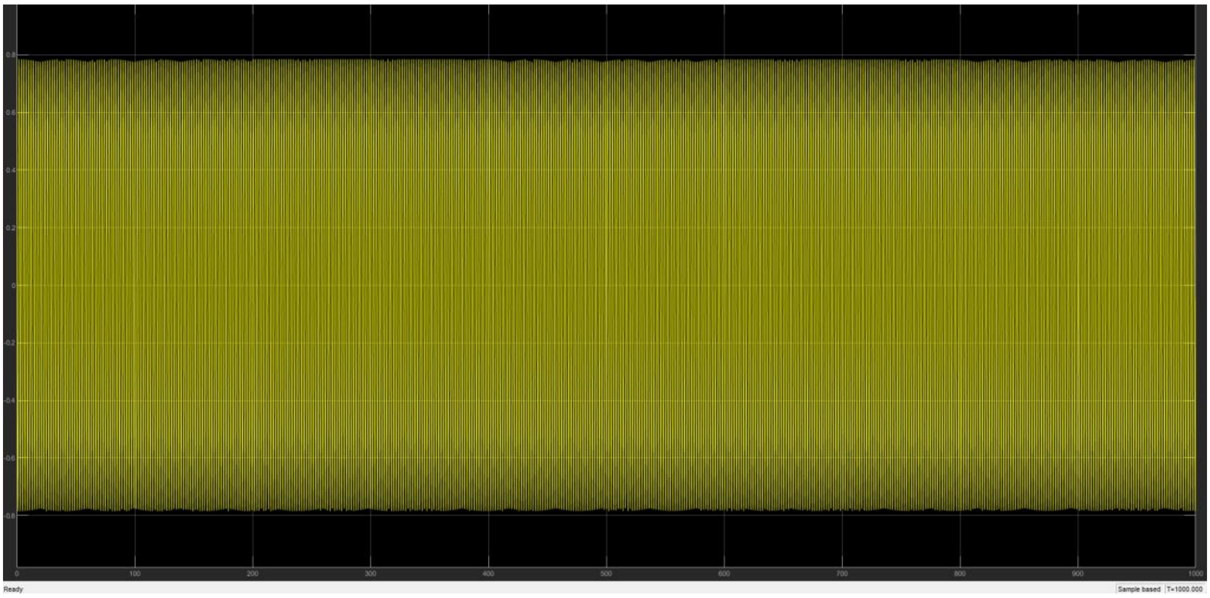
$$\ddot{\theta} = -\frac{g}{l}\sin\theta - \frac{b}{M}\dot{\theta}$$

This is a non linear representation

This is a nonlinear representation where we have a sine in the equation. As we can see the number of oscillations of the simple pendulum are gradually decreasing with time.

Task 2:


-g/l
x
sin
1/s
1/s
-b/M
x
1
1
x
100
Error_measure
-g/l
x
1/s
1/s
0
x


Ready
Sample based
T=1000.000

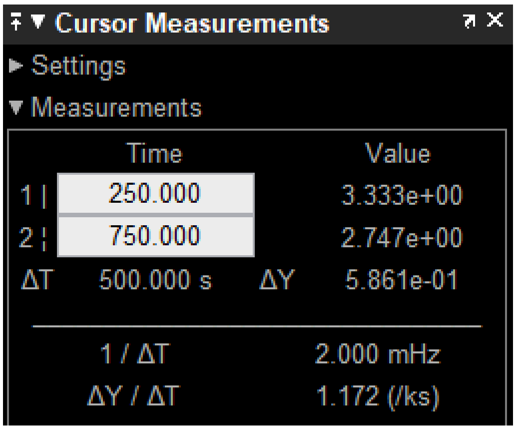
In task 2 it was asked to linearize the equation to find a linearized output of the above equation we have considered sine θ with just θ so that it gets linearized, the equation becomes this after linearization.

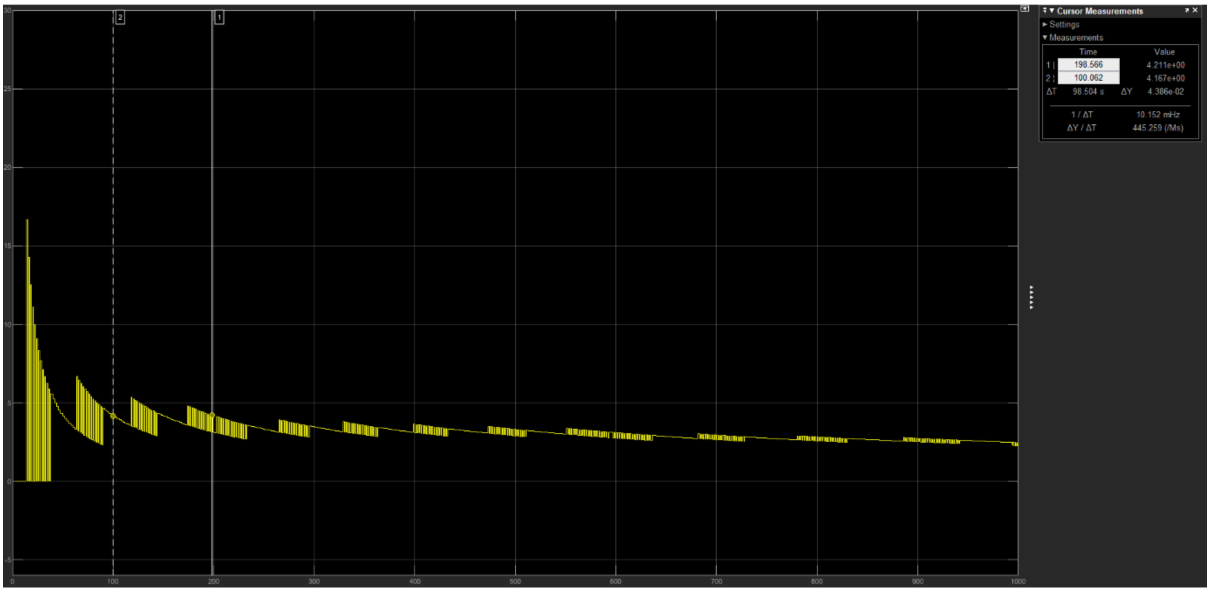
To linearize it consider $\sin\theta \doteq \theta$.

So the equation will transform into

$$\ddot{\theta} = -\frac{g}{l}\theta - \frac{b}{M}\dot{\theta}$$

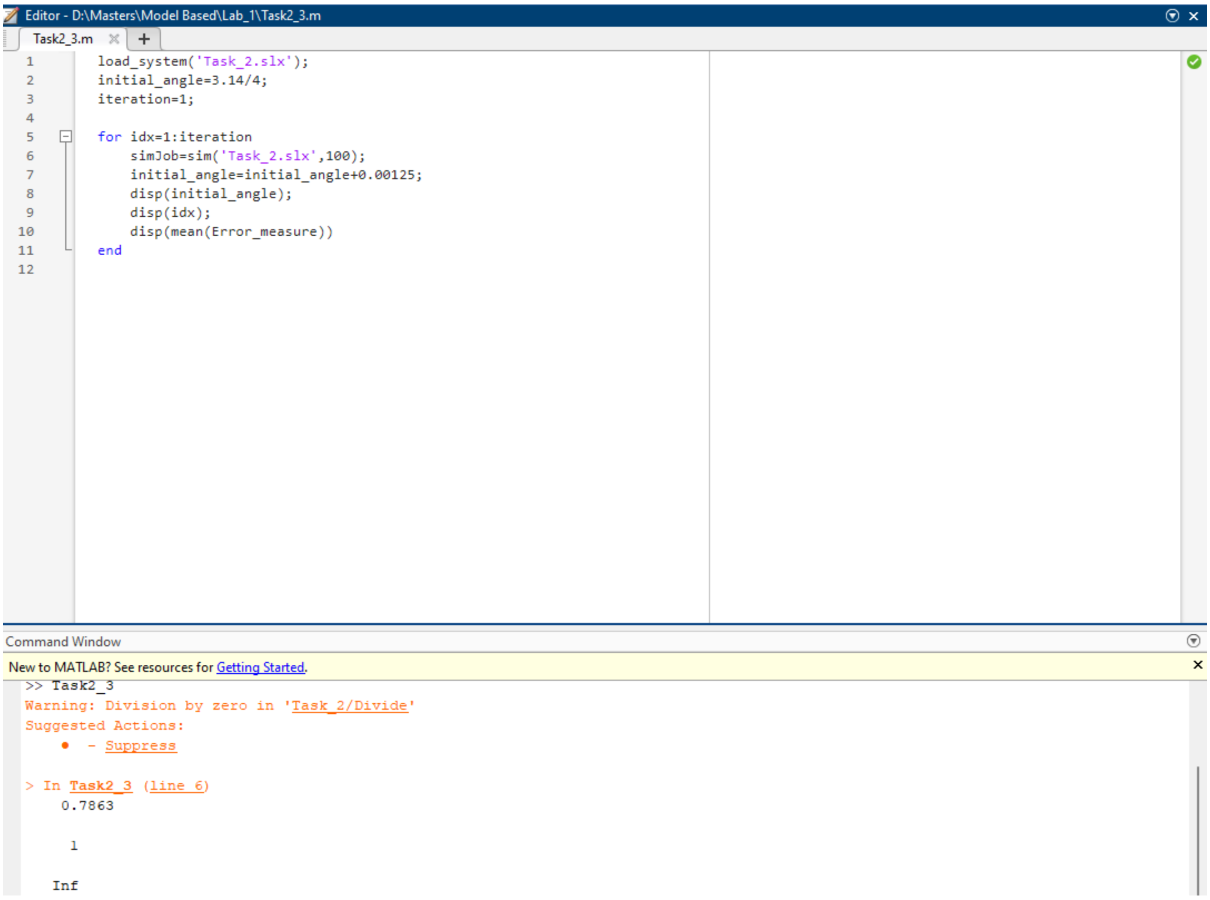
We can observe the waveform to observe the angle is not declining linearly like we observed in task 1. It became linear. We compared both task 1 and task 2 to find the percentage of error in the model caused due to the linearization. In the above model Error is observed as 3%.





To observe the changes in the graphs I used a trigger subsystem to trigger each circuit. so, we connect a scope for observing the final output of the compared graphs of both linear and nonlinear equations. We want to find percentage error between both signals, so we found the difference in the triggered outputs and divided with the nonlinear signal of trigger subsystem and used a gain block for getting a perfect percentage. We finally achieved it and that can be observed in above plot.

Task 3:



Task 3 is to find the angle at which we got 1% error. For this I have used a for loop and iterated with various angles and I found 1% error at an angle of pi/4.