## Q3 Part d)

```
>> ss_point

 Operating point for the Model Q3_model.
 (Time-Varying Components Evaluated at time t=0)

States:
----------
(1.) Q3_model/Absorption Model/Integ1
      x: 0.0388
(2.) Q3_model/Absorption Model/Integ2
      x: 0.101
```

linsys =

A =

| | Integ1 | Integ2 |
|---|---|---|
| Integ1 | -6.5 | 2.5 |
| Integ2 | 4 | -6.5 |

B =

| | FR | FR1 |
|---|---|---|
| Integ1 | -0.001938 | 0.00155 |
| Integ2 | -0.003101 | 0.002481 |

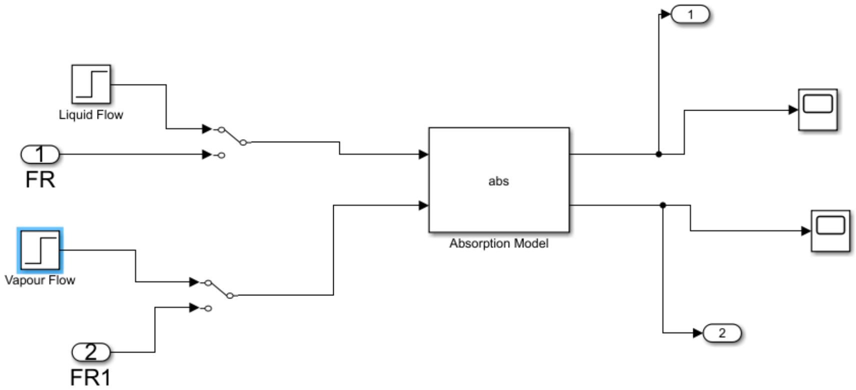
C =

| | Integ1 | Integ2 |
|---|---|---|
| Out1 | 1 | 0 |
| Out2 | 0 | 1 |

D =

| | FR | FR1 |
|---|---|---|
| Out1 | 0 | 0 |
| Out2 | 0 | 0 |

Continuous-time state-space model.

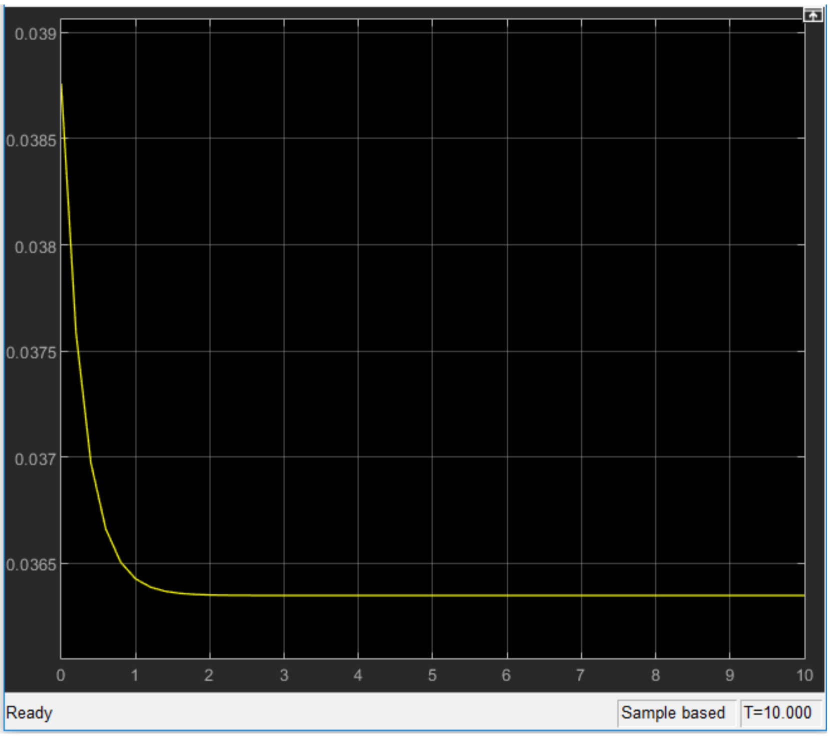



## Part e)

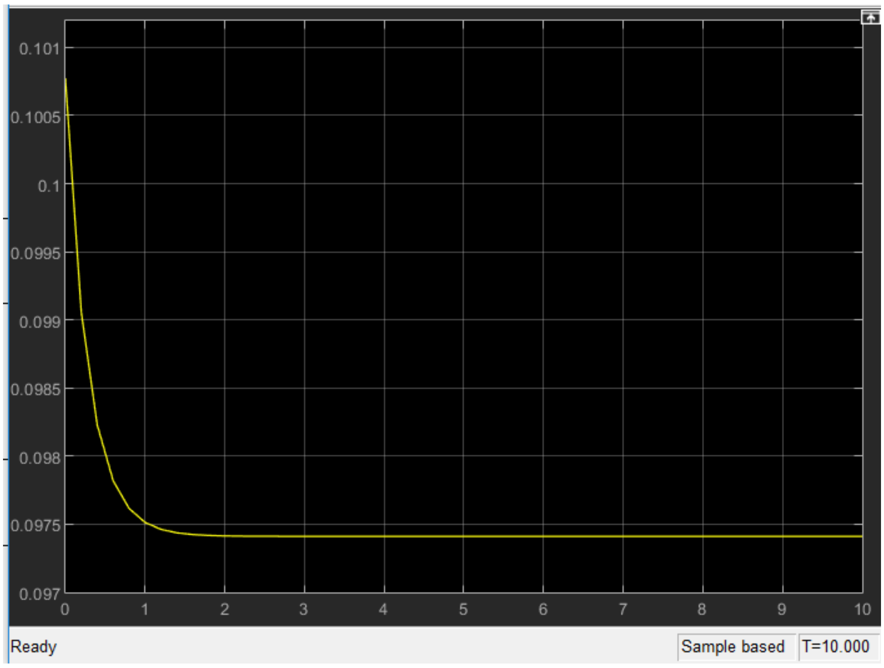
Since if we change both the flow rates, steady state values are same as original, I am changing only L in both cases.

ALL GRAPHS ARE FROM NON LINEAR MODEL. I DID NOT PLOT FOR LINEAR MODEL.

i) $L = 1.05L_{ss}$

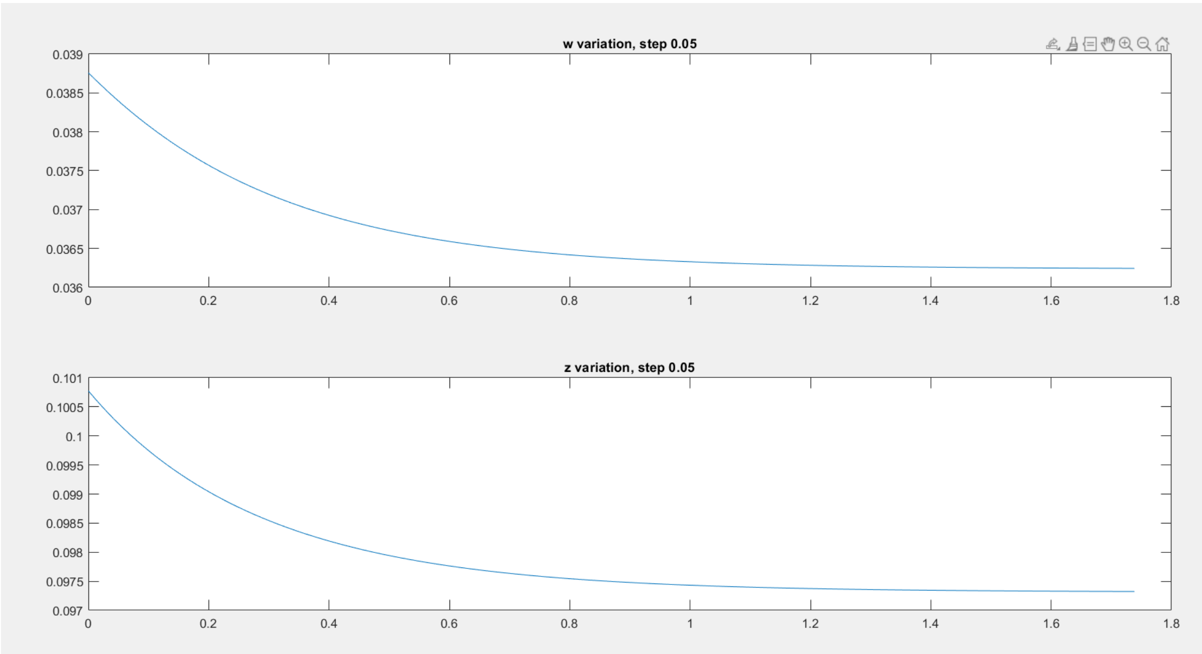



W graph

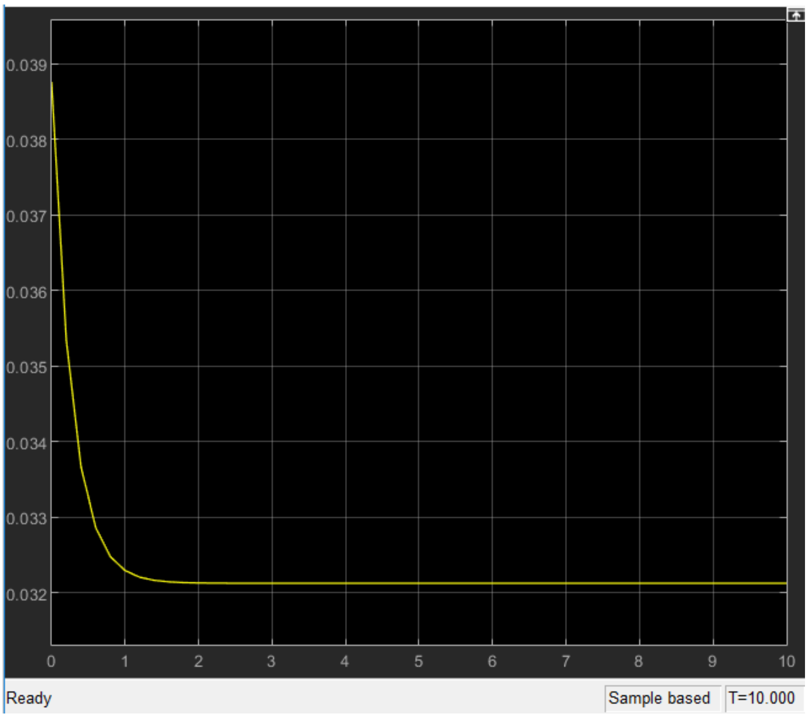



Z graph

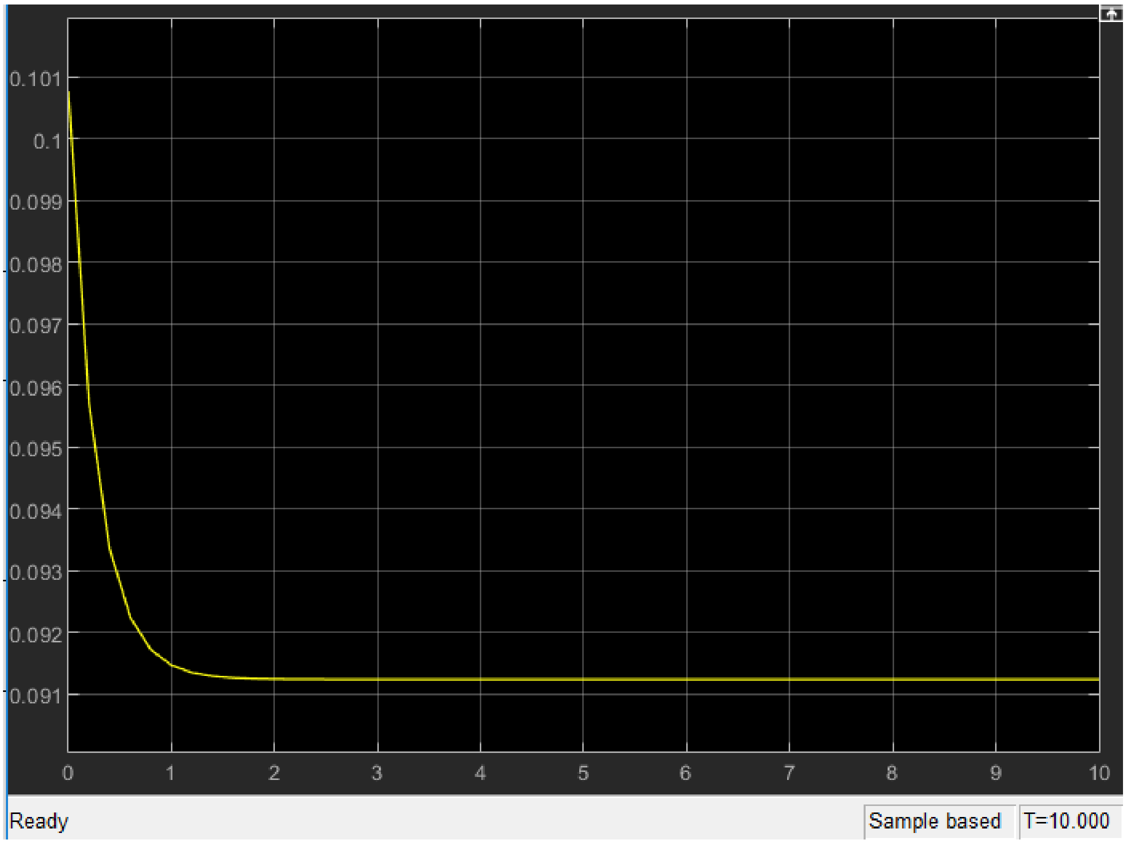
Linear model




ii) $L = 1.15L_{ss}$

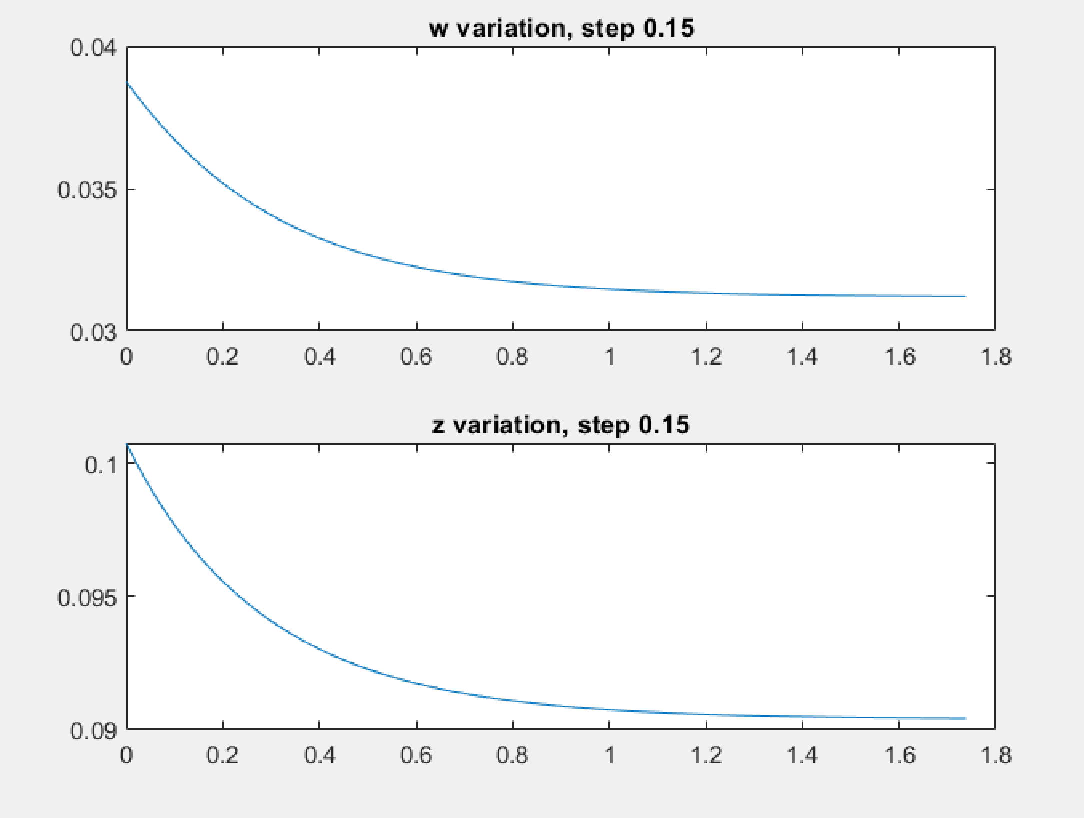



W graph




Z graph

Linear model:




Code:

```
clear;close all;

%% System charecterstics

Lss = 80; Vss = 100;

M = 20; a=0.5; zf = 0.1;

%% Part a) Finding steady state (by hand)

% Equate derivatives to zero, solve the linear eqn

Ass = [-(a*Vss+Lss)/M Vss*a/M;Lss/M -(a*Vss+Lss)/M];

bss = [0;-Vss*zf/M];

x_ss = inv(Ass)*bss;

%% Part b) Linearisation (by Taylor Expansion)

w_ss = x_ss(1);z_ss=x_ss(2);

A = [-(Vss*a+Lss)/M Vss*a/M;Lss/M -(Lss+Vss*a)/M];

B = [-w_ss/M (-a*w_ss+a*z_ss)/M;(w_ss-z_ss)/M -a*z_ss/M+zf/M];

%% Part c) Finding the eigenvalues-eignvectors of the system
```

```
[V,D] = eig(A);
% Second eigen value is faster (more negative)
%% Part d) Find steady-state and linearise
open_system('Q3_model')
% Read the operating conditions into an object
opc = operspec('Q3_model');
% Operating conditions
opc.Inputs(1).u = 80;
opc.Inputs(2).u = 100;
opc.Inputs(1).Known = 1;
opc.Inputs(2).Known = 1;
% Constraints
opc.States(1).Min = 0;opc.States(2).Min = 0;
% Find the steady state point
ss_point = findop('Q3_model',opc);
% Linearize
linsys = linearize('Q3_model',ss_point)
%% Part e) Give step changes and plot
% Done in SIMULINK. Use the manual switch to step input(s)
[Y,T,X]=step(linsys);
% Y(:,:,1) contains responses for change in L
% Since linear system, changes in input and output are proportional
figure();
subplot(2,1,1);plot(T,Y(:,1,1)*.05*Lss+w_ss); title('w variation, step 0.05');
subplot(2,1,2);plot(T,Y(:,2,1)*.05*Lss+z_ss); title('z variation, step 0.05');
figure();
subplot(2,1,1);plot(T,Y(:,1,1)*.15*Lss+w_ss); title('w variation, step 0.15');
subplot(2,1,2);plot(T,Y(:,2,1)*.15*Lss+z_ss); title('z variation, step 0.15');
```