



**AFE
BABALOLA
UNIVERSITY
ADO-EKITI (ABUAD)**

KM. 8.5, AFE BABALOLA WAY,
ADO-EKITI, EKITI STATE, NIGERIA.
P.M.B 5454 ADO-EKITI.

COLLEGE OF ENGINEERING

DEPARTMENT OF CHEMICAL AND PETROLEUM ENGINEERING

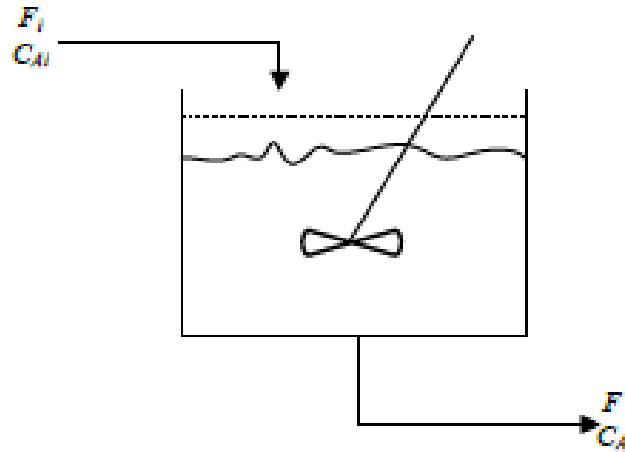
PROCESS DYNAMICS & CONTROL II

CHE 532 ASSIGNMENT I

BY

ABUBAKAR MUNIRATU ONEHDEFOJO

14/ENG01/016



Overall material balance:

$$\{\text{Accumulation of mass}\} = \{\text{mass in}\} - \{\text{mass out}\}$$

$$\frac{d(\rho V)}{dt} = \rho F_i - \rho F \quad (1a)$$

$$\frac{dV}{dt} = F_i - F \quad (1b)$$

Component balance of A

$$\begin{aligned} \{\text{Accumulation of component mass}\} \\ = \{\text{component mass in}\} - \{\text{component mass out}\} \\ + \{\text{generation of component mass}\} \end{aligned}$$

$$\frac{d(C_A V)}{dt} = F_i C_{Ai} - F C_A + V r_A$$

But:

$$r_A = -K C_A$$

$$\frac{d(C_A V)}{dt} = V \frac{dC_A}{dt} + C_A \frac{dV}{dt}$$

Therefore:

$$V \frac{dC_A}{dt} + C_A \frac{dV}{dt} = F_i C_{Ai} - F C_A - V K C_A$$

$$V \frac{d(C_A)}{dt} = F_i C_{Ai} - F C_A - V K C_A - C_A \frac{dV}{dt} \quad (2)$$

Recall:

$$\frac{dV}{dt} = F_i - F$$

Therefore:

$$V \frac{d(C_A)}{dt} = F_i C_{Ai} - F C_A - V K C_A - C_A (F_i - F)$$

$$V \frac{d(C_A)}{dt} = F_i C_{Ai} - F C_A - V K C_A - F_i C_A + F C_A$$

$$V \frac{d(C_A)}{dt} = F_i C_{Ai} - V K C_A - F_i C_A$$

$$V \frac{d(C_A)}{dt} = F_i C_{Ai} - C_A (F_i + V K)$$

$$V \frac{d(C_A)}{dt} + C_A (F_i + V K) = F_i C_{Ai}$$

$$F_i = F$$

$$\frac{d(C_A)}{dt} + \left(\frac{F + V K}{V} \right) C_A = \frac{F}{V} C_{Ai}$$

$$\frac{d(C_A)}{dt} + \frac{1}{\tau_p} C_A = \frac{F}{V} C_{Ai} \quad (3)$$

$$\tau_p \frac{d(C_A)}{dt} + C_A = \frac{F \tau}{V} C_{Ai}$$

$$\tau_p \frac{d(C_A)}{dt} + C_A = \frac{F}{V} * \frac{V}{F + V K} C_{Ai}$$

$$\tau_p \frac{d(C_A)}{dt} + C_A = \frac{F}{F + V K} C_{Ai}$$

$$\tau_p \frac{d(C_A)}{dt} + C_A = K_p C_{Ai}$$

$$\tau_p \frac{d(C_{As})}{dt} + C_{As} = K_p C_{Ais}$$

With time constant $\tau_p = \frac{V}{F + VK}$ *

where the steady state gain, $K_p = \frac{F}{F + Vk}$ **

Equation 3 is the dynamic equation. To find the transfer function, we'll have to get the Laplace of the system:

$$\overline{C_A} = C_A(s)$$

$$\overline{C_{Ai}} = C_{Ai}(s)$$

$$\overline{C_A}'(t) = sC_A(s) - C_A(0)$$

$$\tau_p \frac{d(C_A - C_{As})}{dt} + (C_A - C_{As}) = K_p (C_{Ai} - C_{Ais})$$

$$\tau_p \frac{d(\overline{C_A})}{dt} + \overline{C_A} = K_p \overline{C_{Ai}}$$

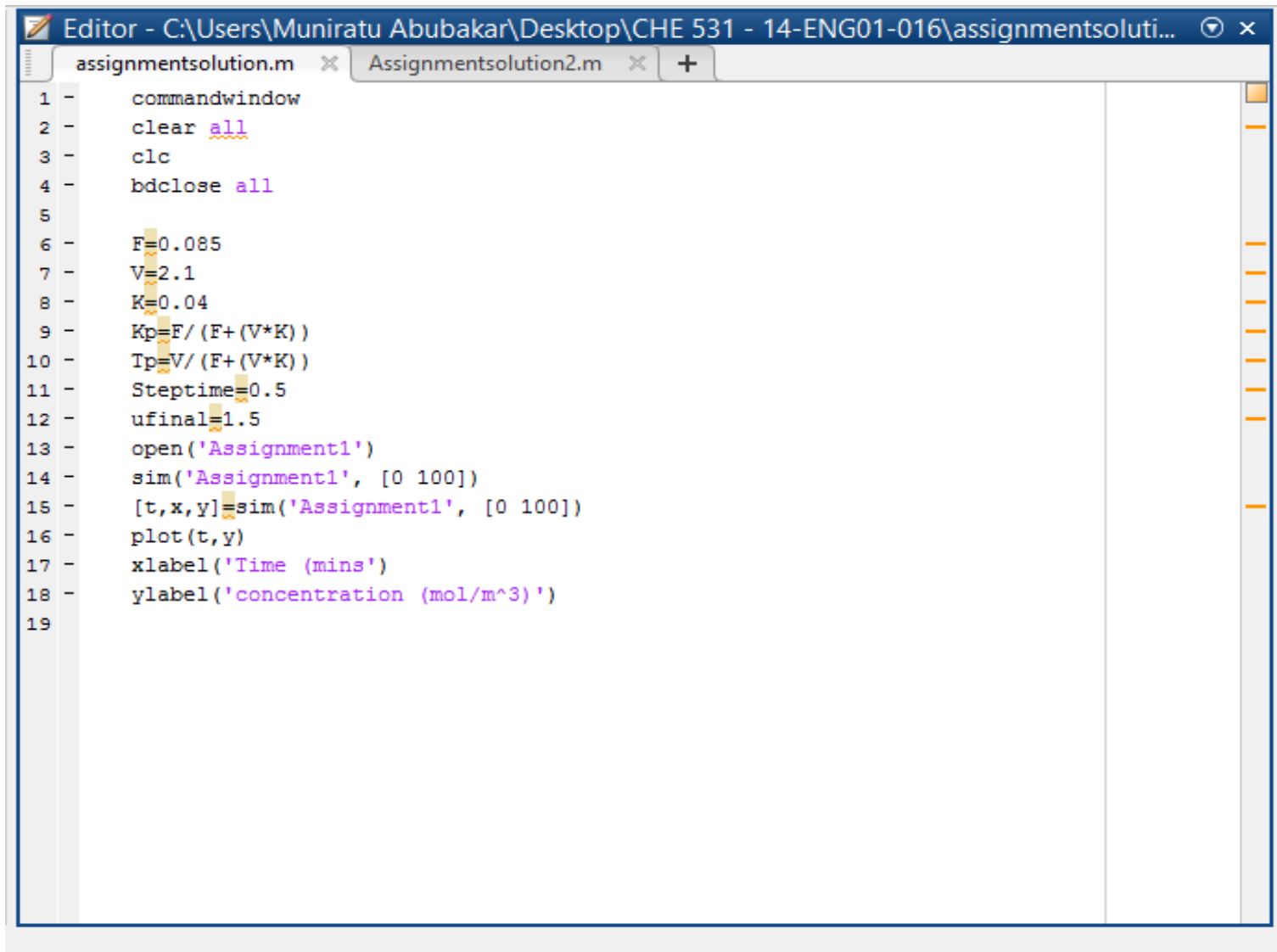
$$\tau_p [S\overline{C_A}(s) - \overline{C_A}(0)] + \overline{C_A}(s) = K_p \overline{C_{Ai}}(s)$$

$$\tau_p S\overline{C_A}(s) + \overline{C_A}(s) = K_p \overline{C_{Ai}}(s)$$

$$\overline{C_A}(s)(\tau_p S + 1) = K_p \overline{C_{Ai}}(s)$$

$$\frac{\overline{C_A}(s)}{\overline{C_{Ai}}(s)} = \frac{K_p}{(\tau_p S + 1)}$$

$$G(s) = \frac{\overline{C_A}(s)}{\overline{C_{Ai}}(s)} = \frac{K_p}{(\tau_p S + 1)}$$



The image shows a MATLAB Editor window with the title bar "Editor - C:\Users\Muniratu Abubakar\Desktop\CHE 531 - 14-ENG01-016\assignmentsoluti...". The window contains two tabs: "assignmentsolution.m" and "Assignmentsolution2.m". The "assignmentsolution.m" tab is active, displaying a MATLAB script with 19 lines of code. The code initializes the command window, clears all variables, and closes all figure windows. It then defines parameters F, V, and K, and calculates Kp and Tp. The simulation is set up with a step time of 0.5 and a final time of 1.5. The script opens a figure window named 'Assignment1', runs a simulation of the 'Assignment1' model, and plots the concentration over time. The x-axis is labeled 'Time (mins)' and the y-axis is labeled 'concentration (mol/m^3)'.

```
1 - commandwindow
2 - clear all
3 - clc
4 - bdclose all
5
6 - F=0.085
7 - V=2.1
8 - K=0.04
9 - Kp=F/(F+(V*K))
10 - Tp=V/(F+(V*K))
11 - Steptime=0.5
12 - ufinal=1.5
13 - open('Assignment1')
14 - sim('Assignment1', [0 100])
15 - [t,x,y]=sim('Assignment1', [0 100])
16 - plot(t,y)
17 - xlabel('Time (mins)')
18 - ylabel('concentration (mol/m^3)')
19
```

Figure 1. 1. open loop dynamic model simulation

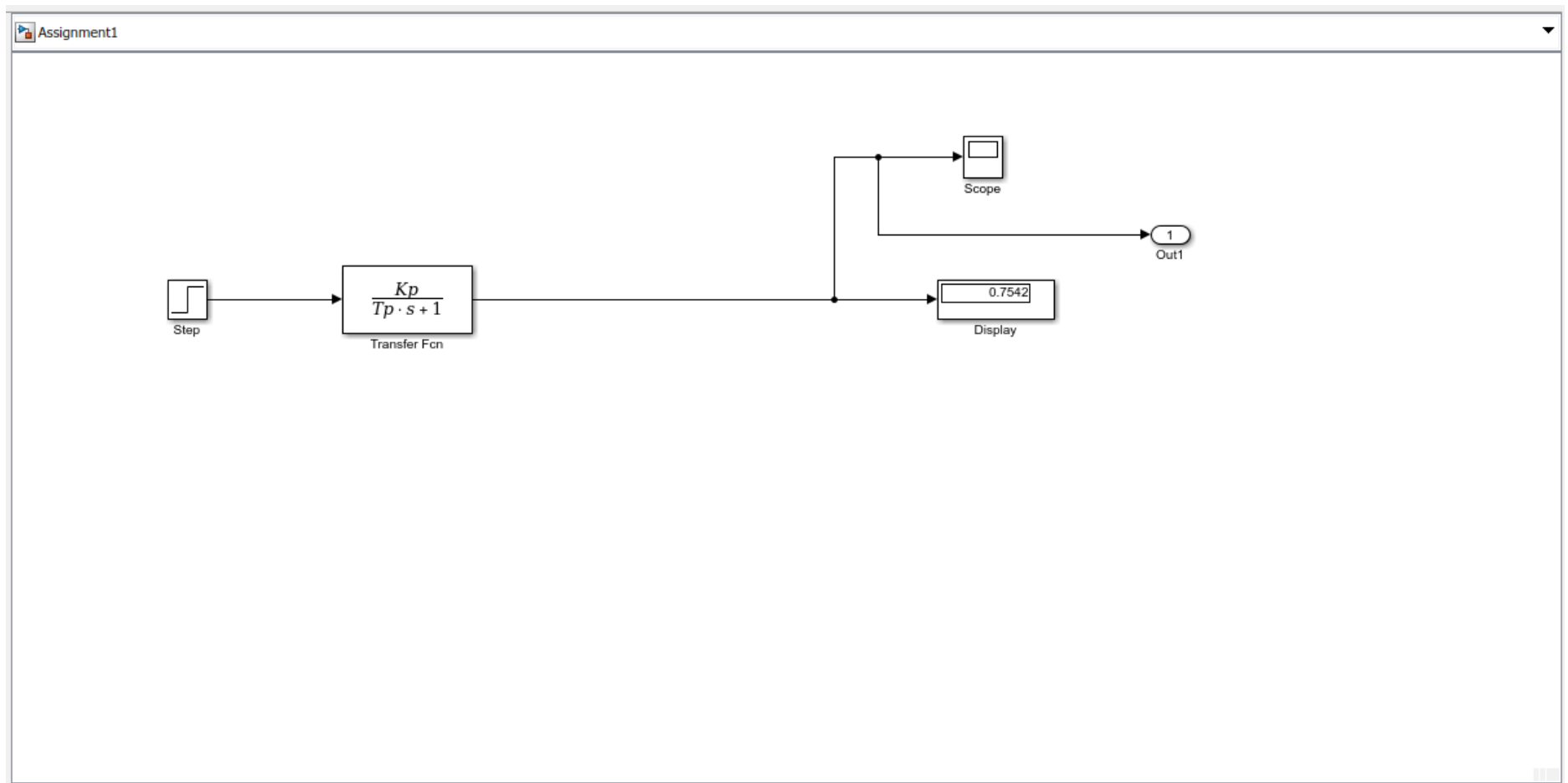


Figure 1. 2. Open loop dynamic model

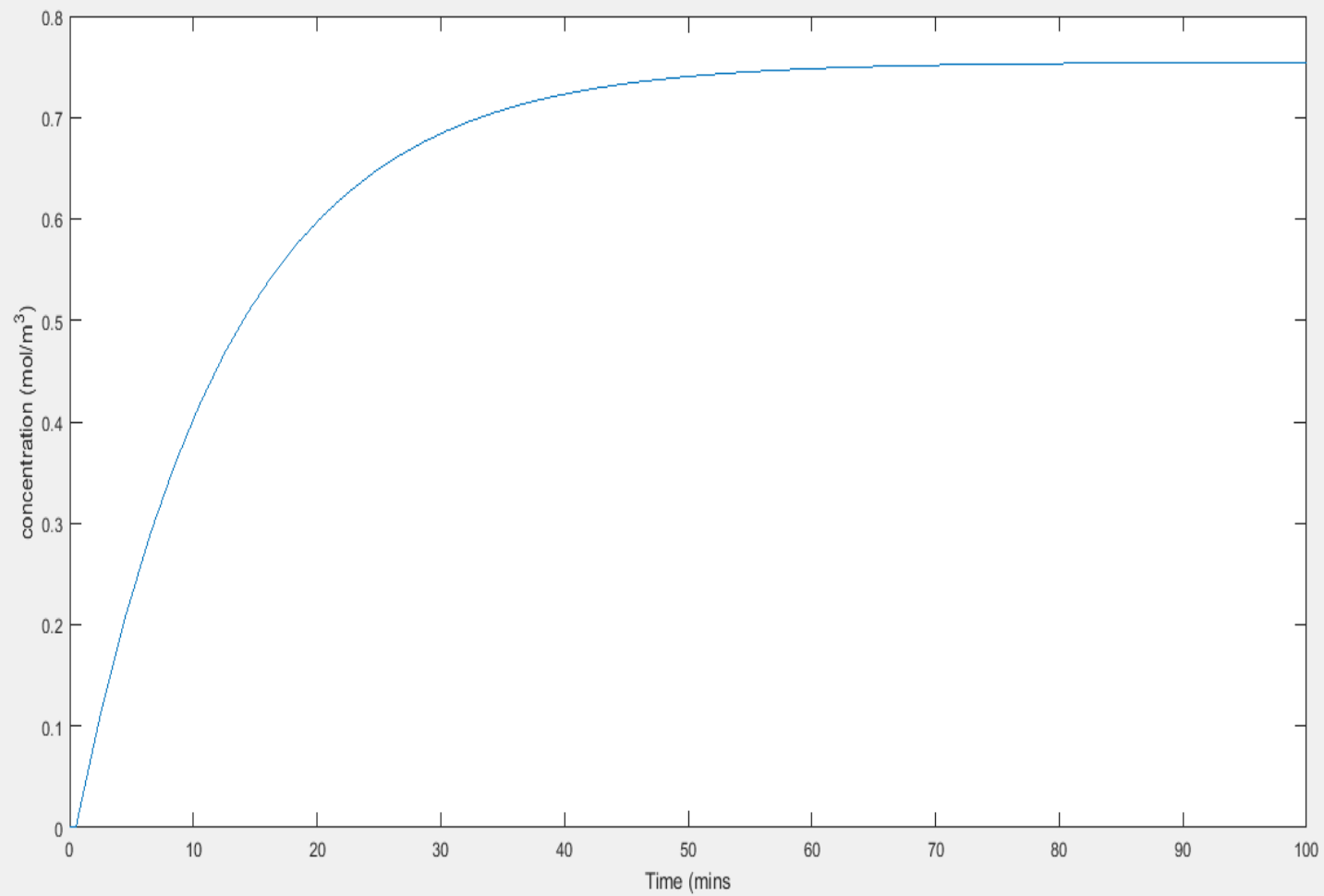
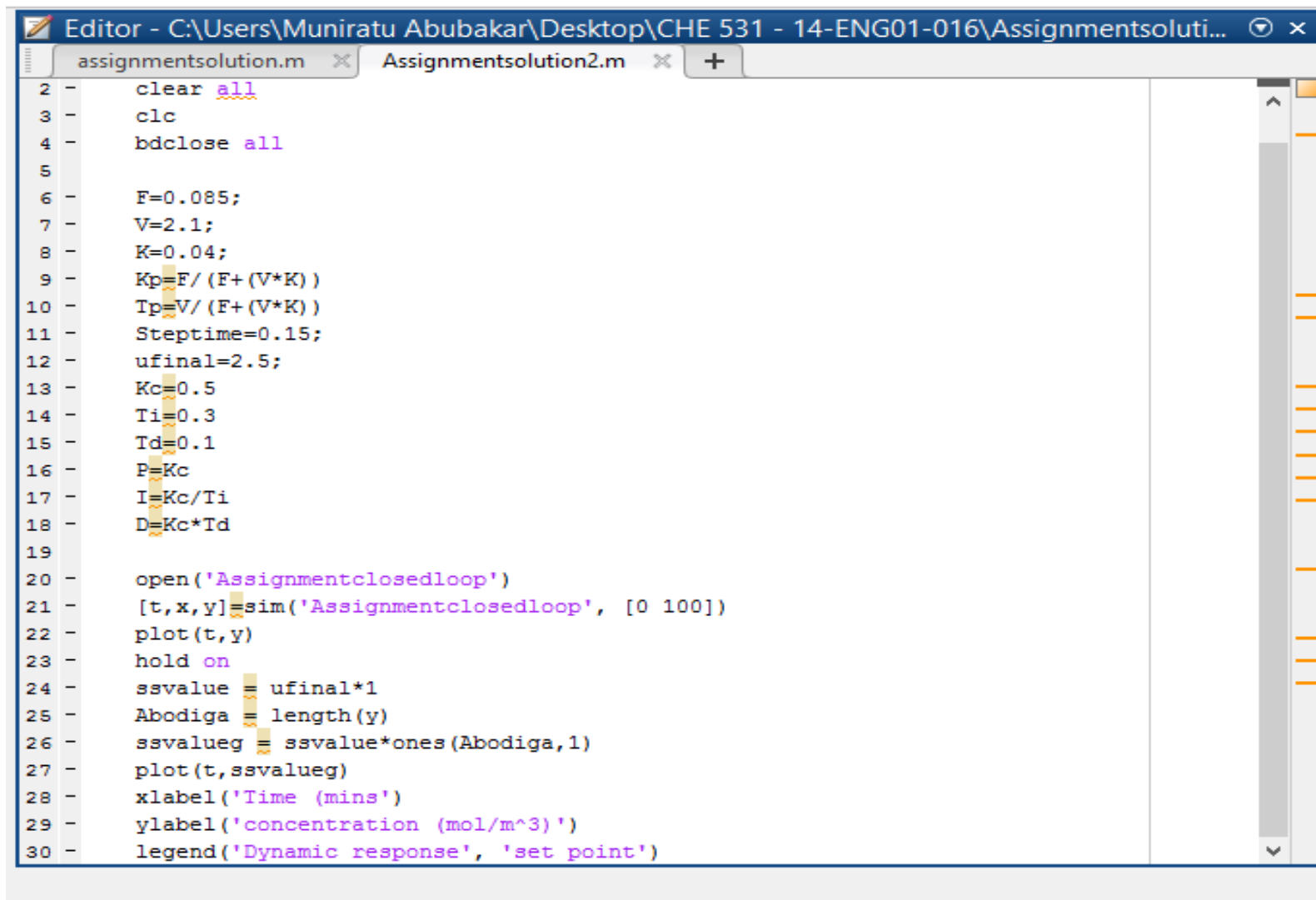


Figure 1. 3. Open loop dynamic model plot



The image shows a MATLAB Editor window with two tabs: 'assignmentsolution.m' and 'Assignmentssolution2.m'. The active tab is 'Assignmentssolution2.m', which contains a MATLAB script for a closed-loop dynamic model simulation. The script includes parameter definitions, controller calculations, simulation setup, and plotting instructions. The window title is 'Editor - C:\Users\Muniratu Abubakar\Desktop\CHE 531 - 14-ENG01-016\Assignmentsoluti...'. The script lines are as follows:

```
2 - clear all
3 - clc
4 - bdclose all
5
6 - F=0.085;
7 - V=2.1;
8 - K=0.04;
9 - Kp=F/(F+(V*K))
10 - Tp=V/(F+(V*K))
11 - Steptime=0.15;
12 - ufinal=2.5;
13 - Kc=0.5
14 - Ti=0.3
15 - Td=0.1
16 - P=Kc
17 - I=Kc/Ti
18 - D=Kc*Td
19
20 - open('Assignmentclosedloop')
21 - [t,x,y]=sim('Assignmentclosedloop', [0 100])
22 - plot(t,y)
23 - hold on
24 - ssvalue = ufinal*1
25 - Abodiga = length(y)
26 - ssvalueg = ssvalue*ones(Abodiga,1)
27 - plot(t,ssvalueg)
28 - xlabel('Time (mins)')
29 - ylabel('concentration (mol/m^3)')
30 - legend('Dynamic response', 'set point')
```

Figure 1. 4. closed loop dynamic model simulation

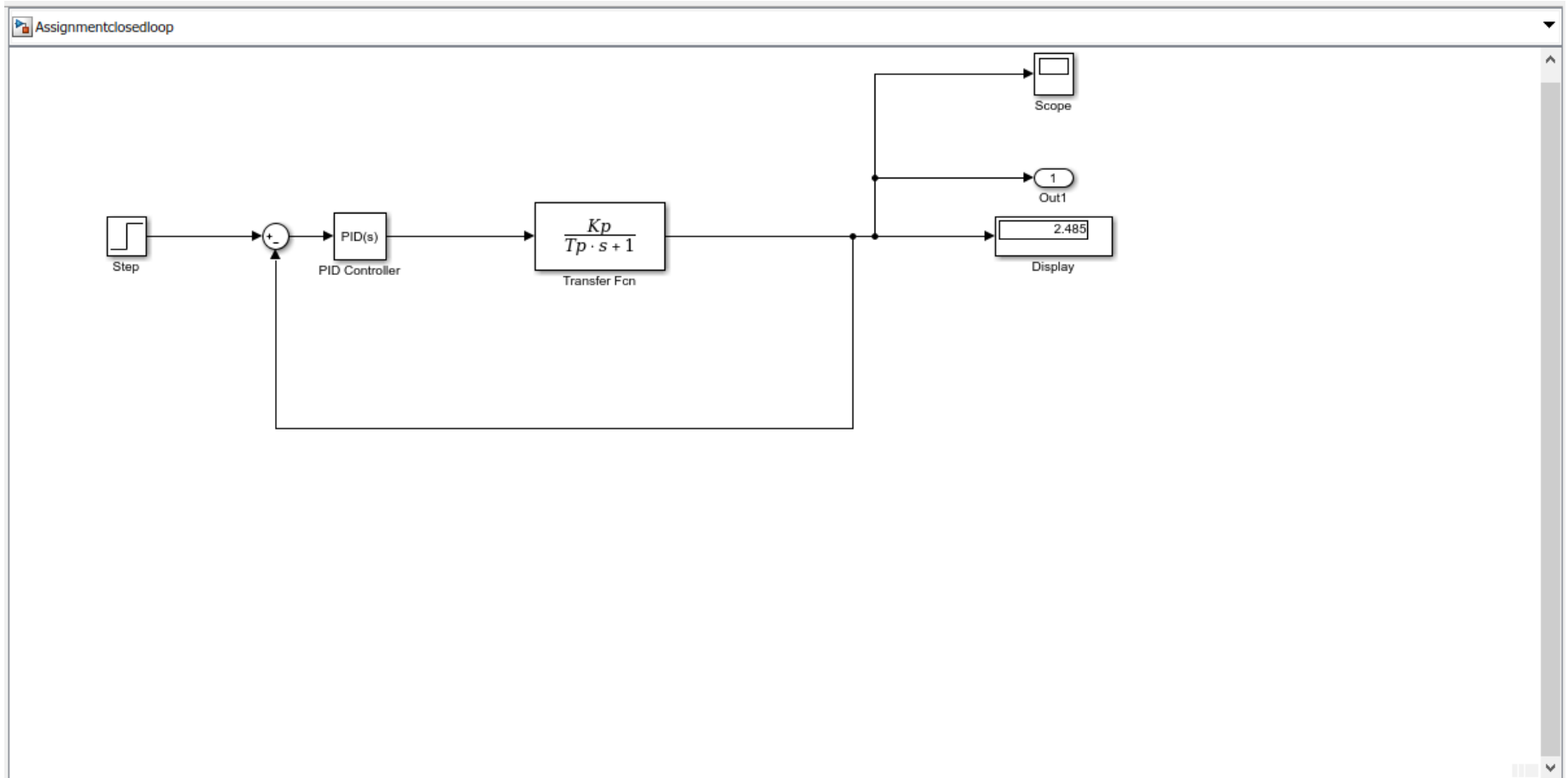


Figure 1. 5. Closed loop dynamic model

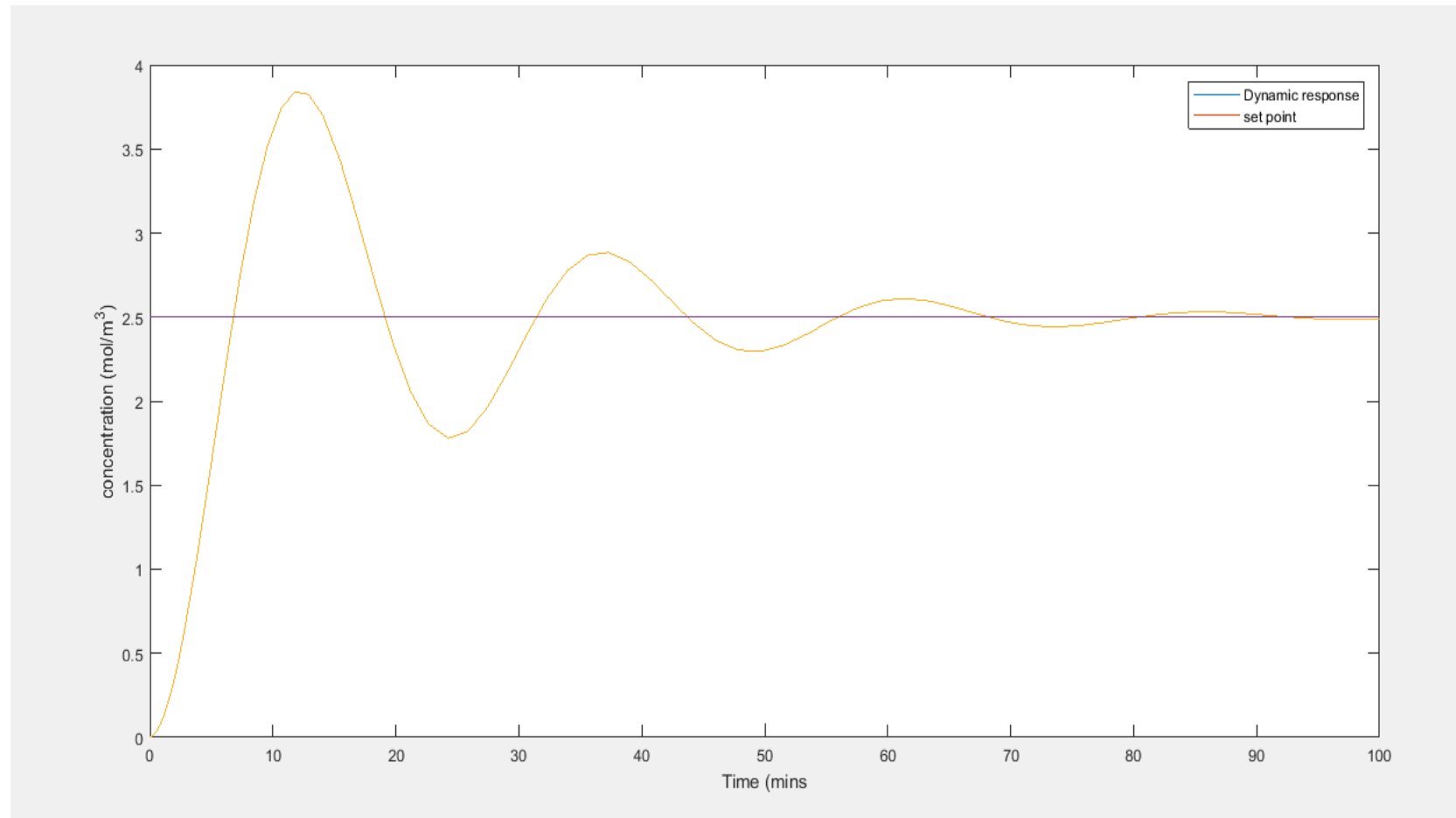


Figure 1. 6. Closed loop dynamic model plot