الجامعة الهاشمية

Submitted to the

Mechatronics Engineering Department

The Hashemite University

The project of Artificial Intelligence

(Fuzzy Logic Control on spring mass damper system)

Supervised by:

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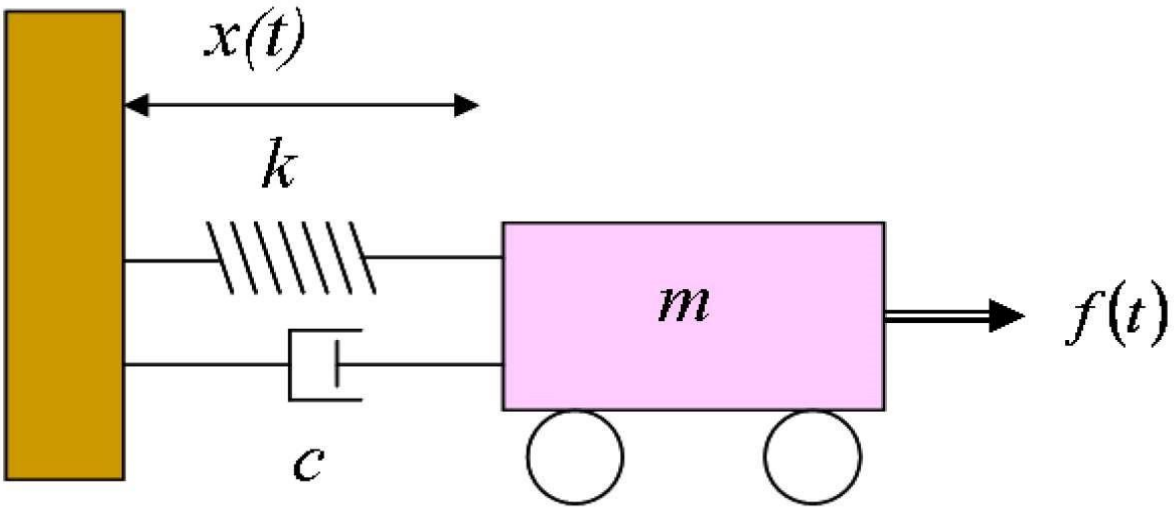
Objectives:

- Vibration is a big problem in many industries. So active control for vibration is a very important topic with lots of applications and fiscal benefit.
- In this project fuzzy logic algorithm will be used in MATLAB Simulink for modeling a vibration control system.
- The primary goal of this project is to observe the control system and construct a rule base that works effectively.
- In this project we want to control a spring-mass-damper system using fuzzy logic controller.

The System:

Our System is a spring-mass-damper system, with the following parameters:



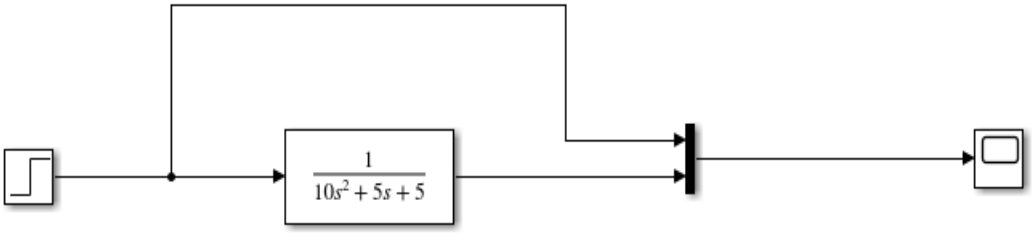
M: Mass.	10 kg
K: Spring coefficient.	5 N/m= 5 kg/s^2
C: Damping coefficient.	5 kg/s

F(t): Time dependent external force applied to the dynamic system.

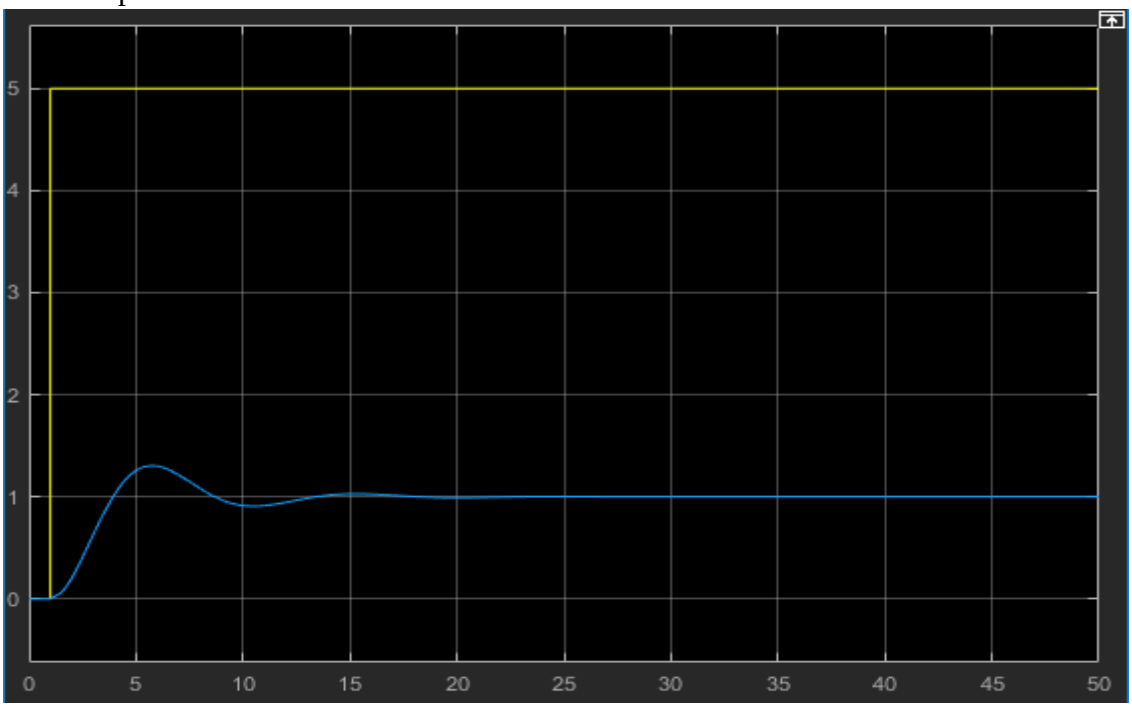
X(t): Time dependent displacement.

System Model:

1. When the input is (step) with final value=5:

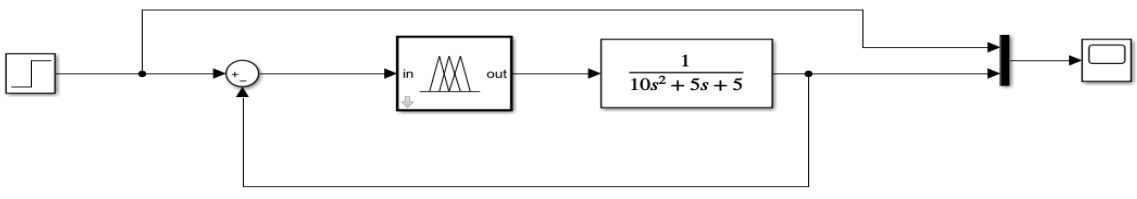


And the response is 1:



The max. of engineering force is 5 N

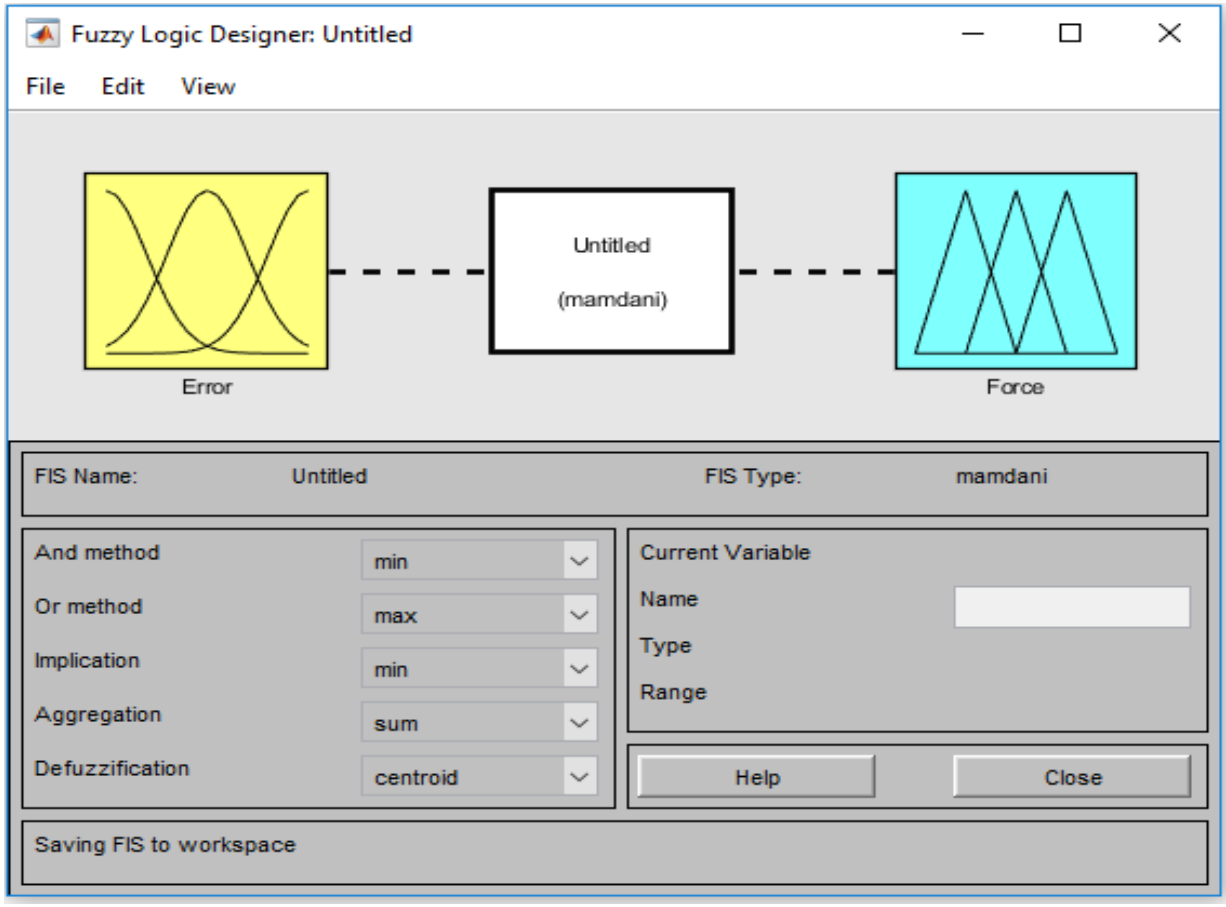
Now we will add the fuzzy logic controller to the system model:



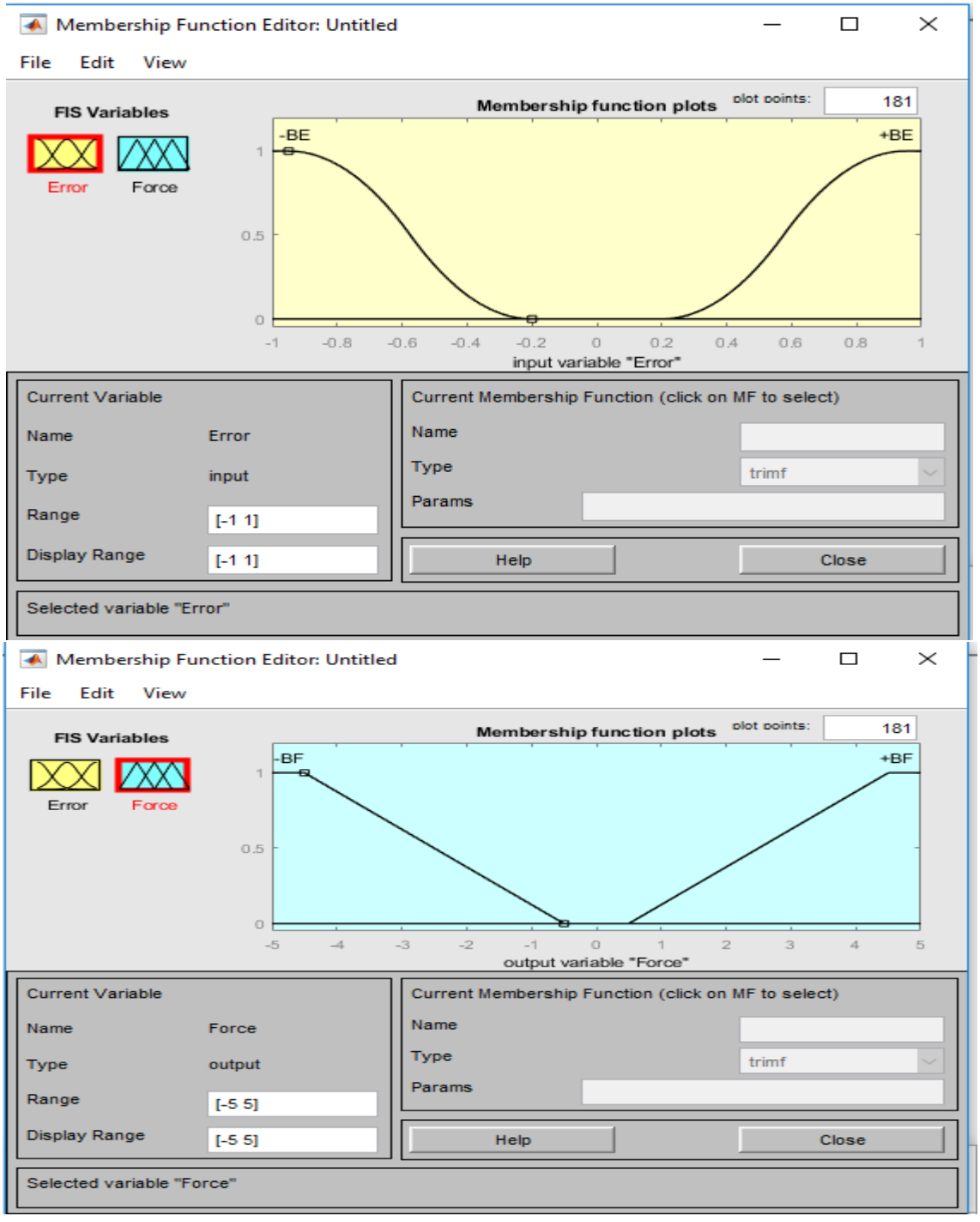
Also, we add it to the models with ramp and sine inputs.

Fuzzy Logic Controller Steps:

1. Choosing the fuzzy type: (Mamdani), and editing methods (and, or, implication, aggregiation and defuzziffication).

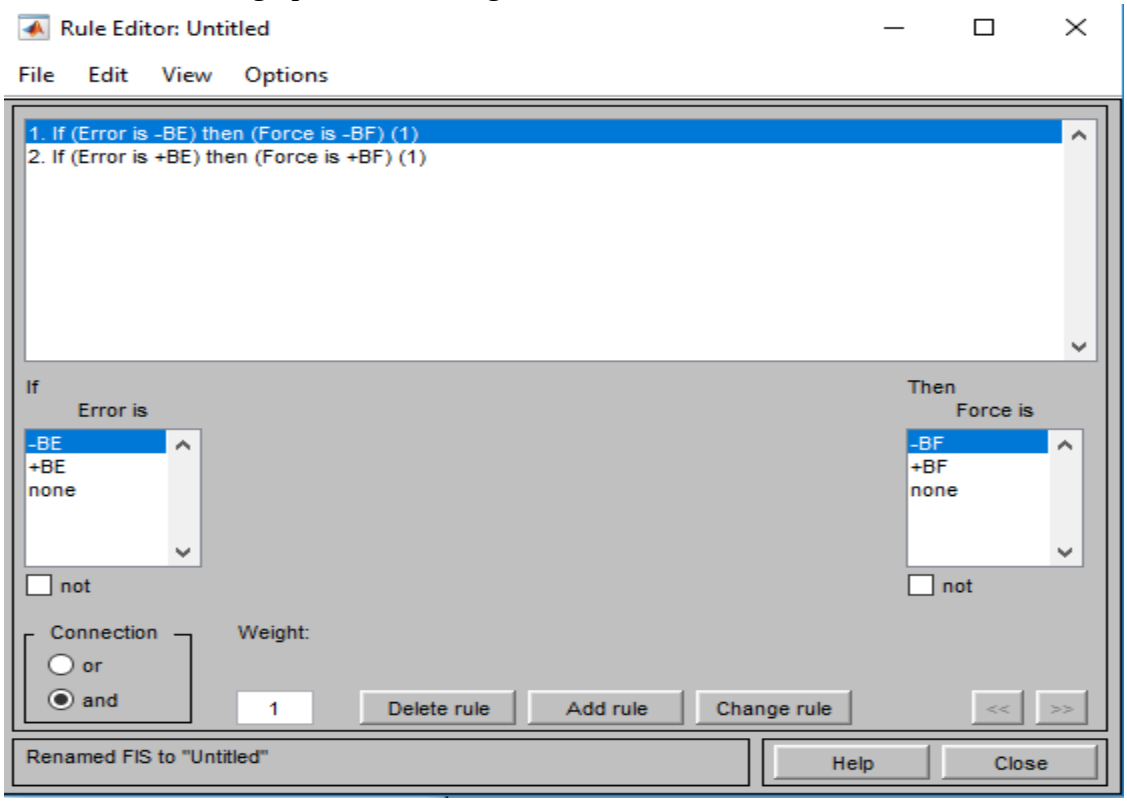


2. Naming input and output variables and choosing the number of inputs & entering the fuzzy sets and choosing the type of each of the membership functions (trapmf, trimf, …) of the inputs and the outputs with choosing the range of discourse for the inputs and the outputs parameters

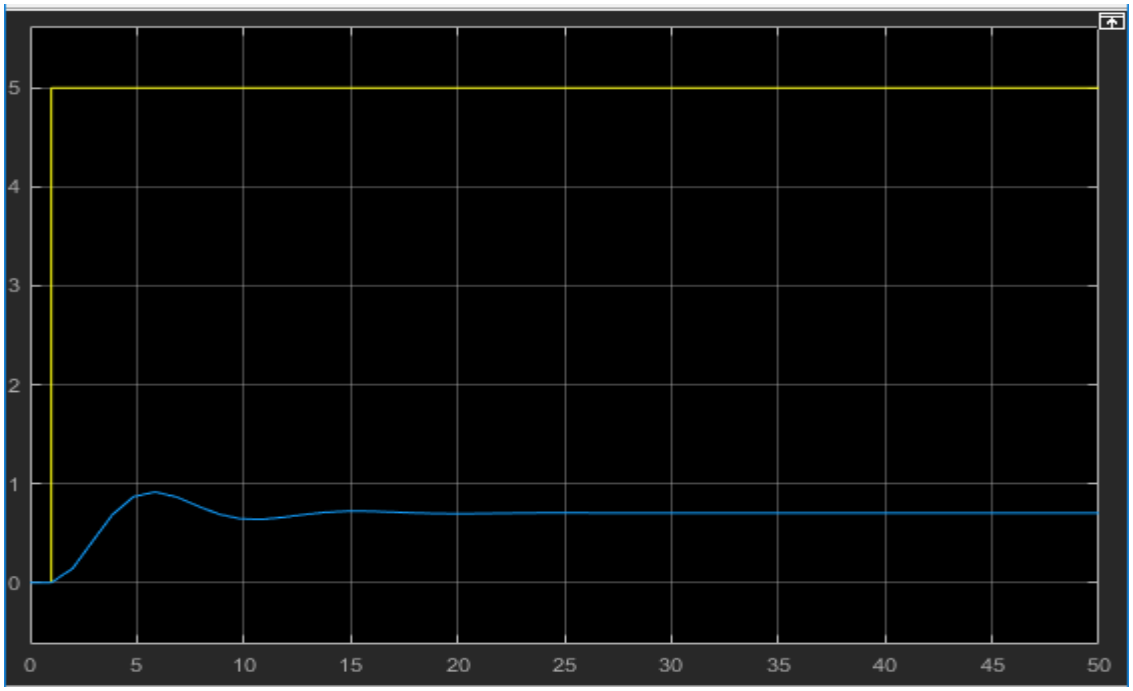


Initially we choose the range of the input (error) [-1 1] and the output (force) [-5 5].

3. Setting up the rules using the Rule Editor.

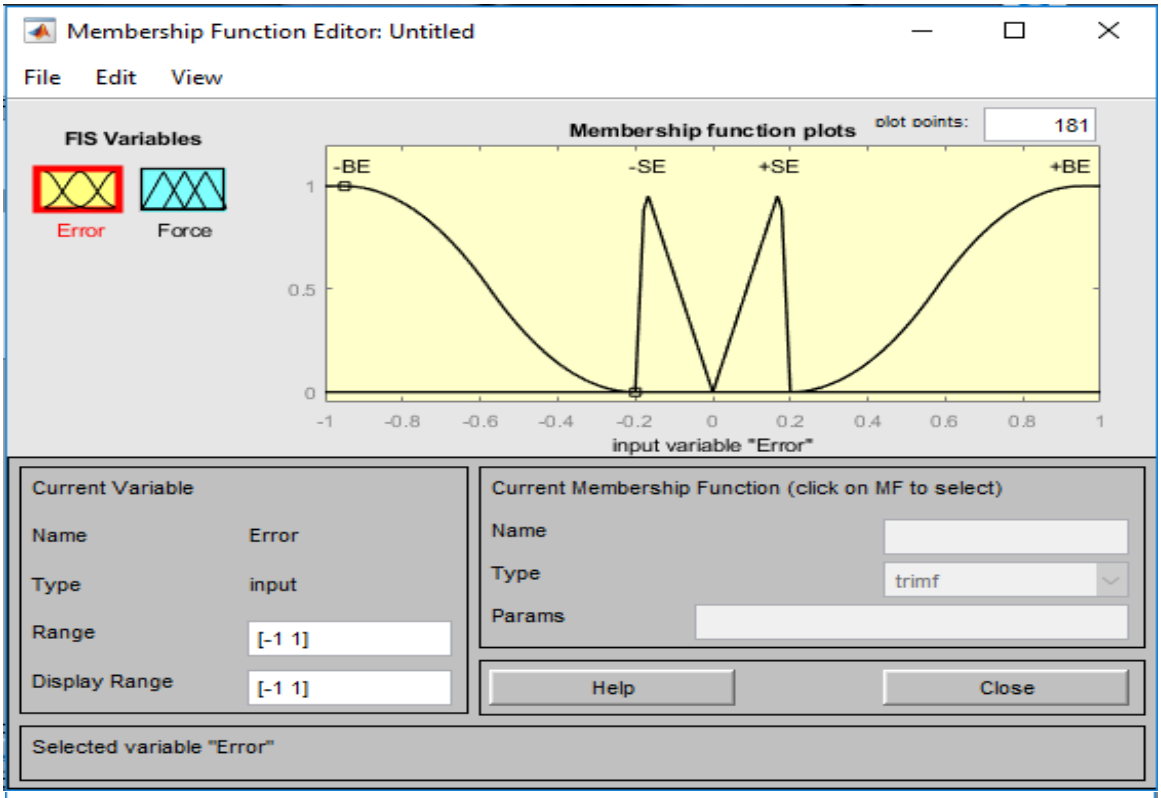


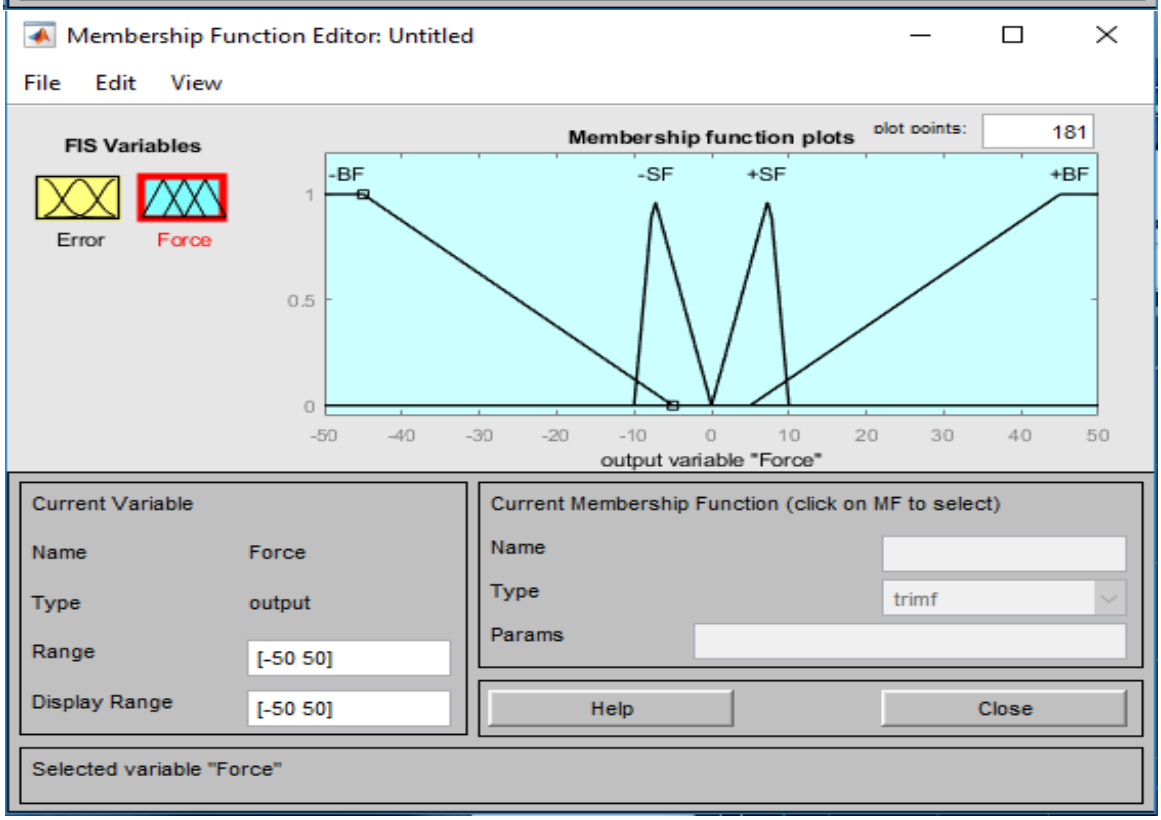
First Trial response :-

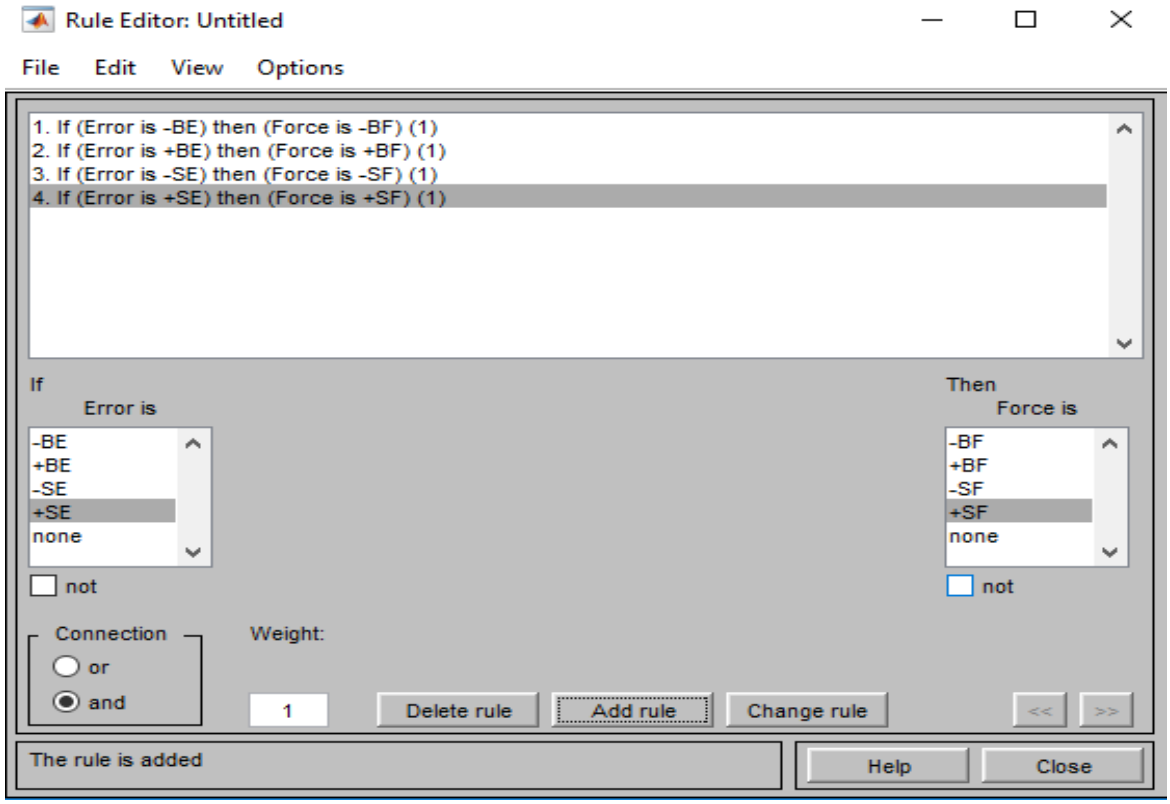


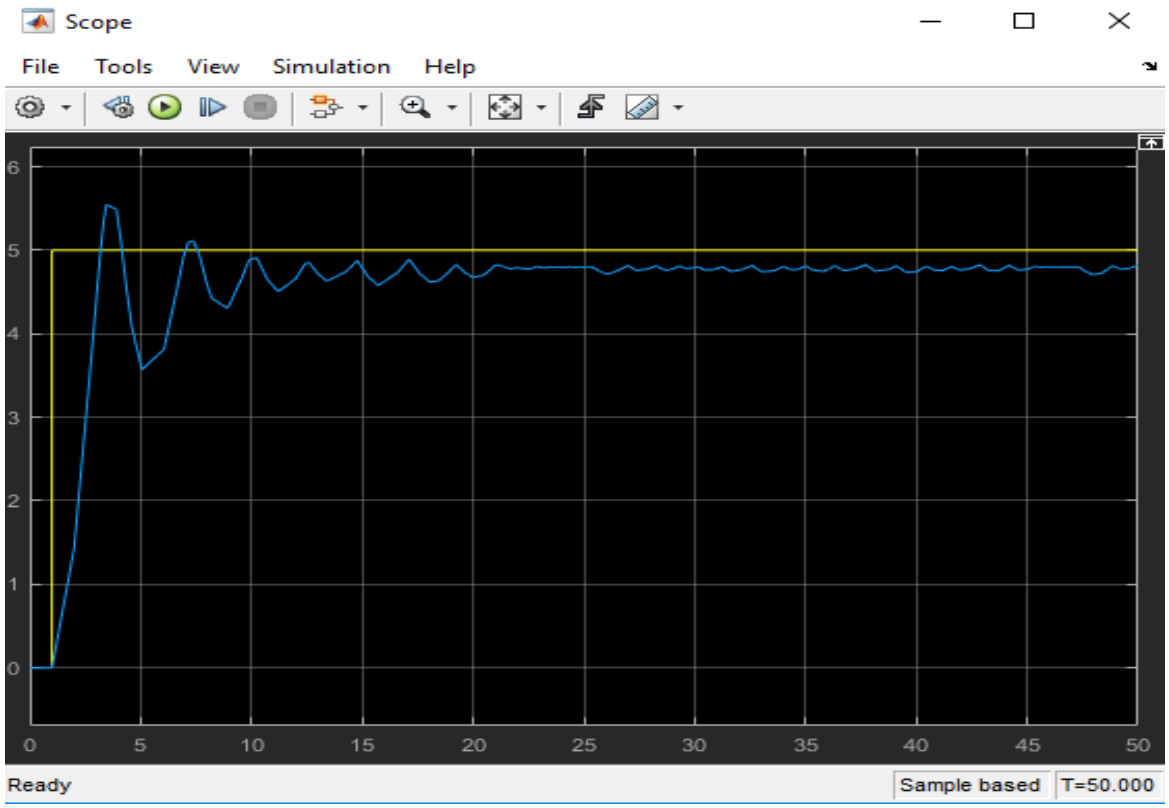
- So, the output responses show us that the error is very large. We will try to decrease it in the second trial as we will show.

Second Trial :-



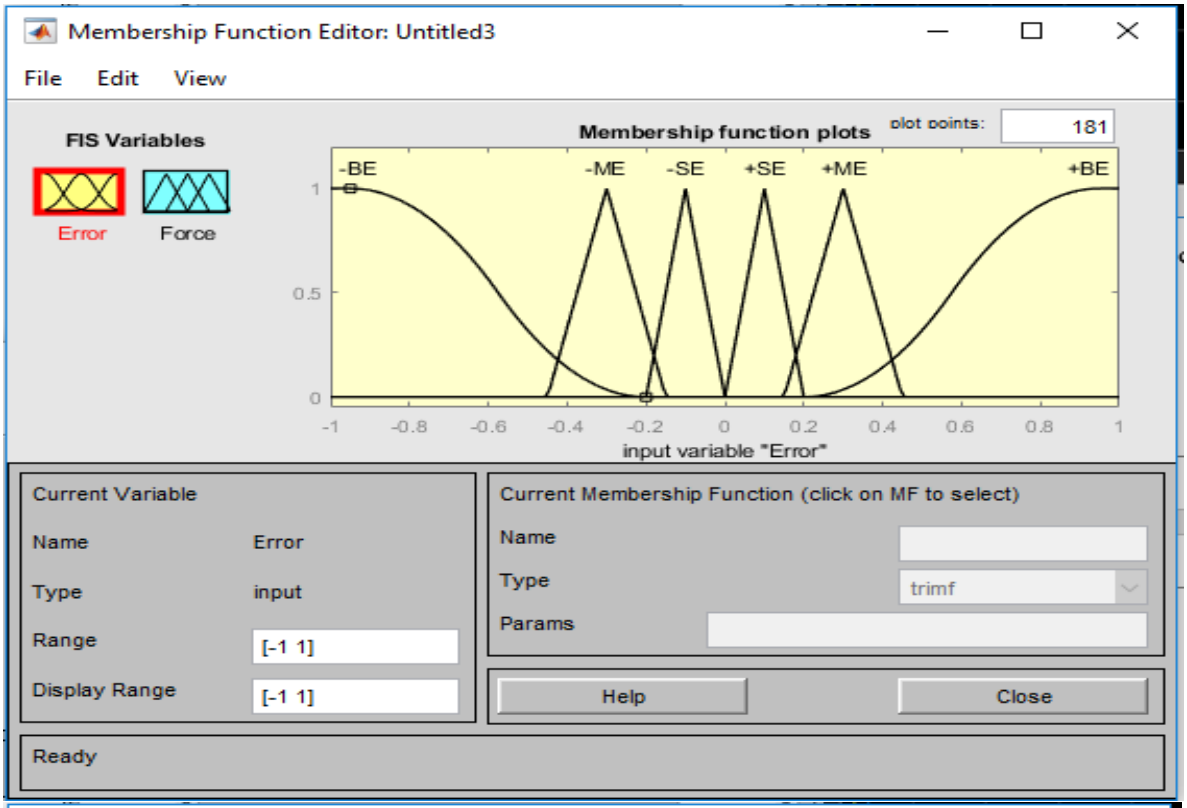


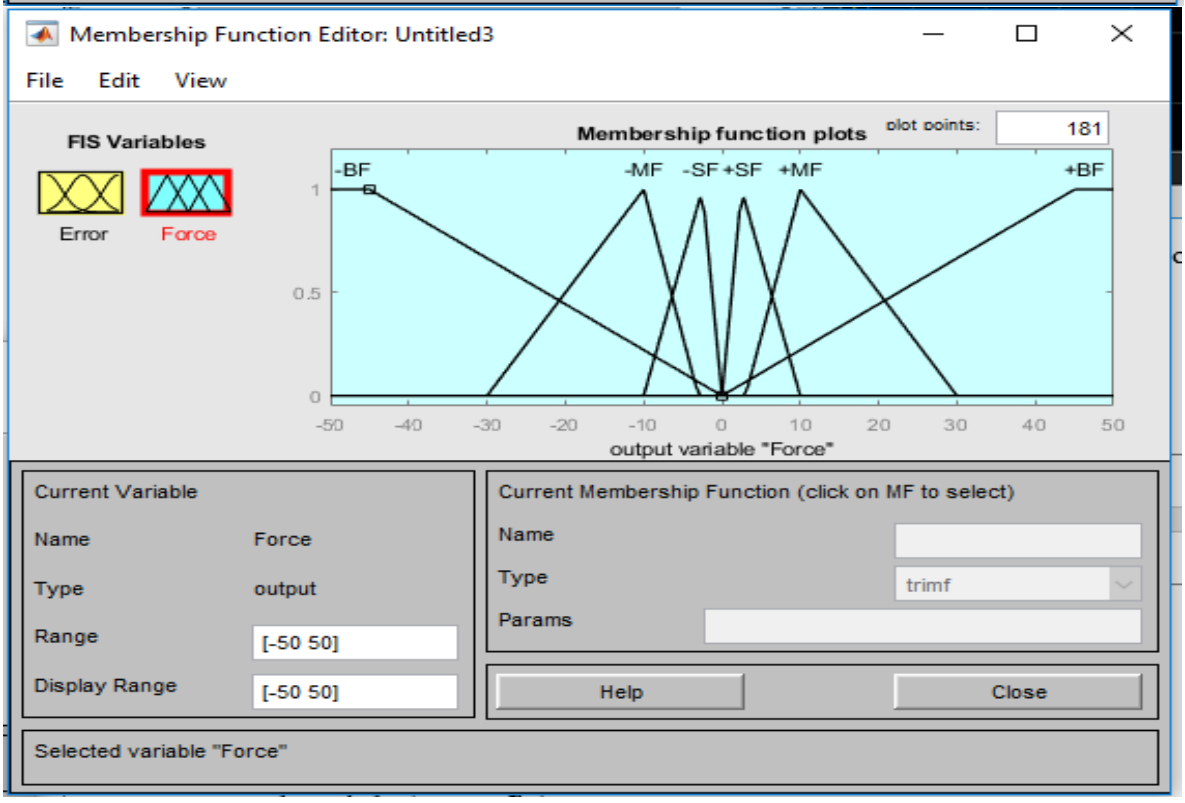




- So, the output responses show us that the error is small. We will try to decrease it in the third trial as we will show.

Third Trial :-


Membership Function Editor: Untitled3
File Edit View
FIS Variables
Error
Force
Membership function plots
plot points:
181
-BE
-ME
-SE
+SE
+ME
+BE
input variable "Error"
Current Variable
Name Error
Type input
Range [-1 1]
Display Range [-1 1]
Current Membership Function (click on MF to select)
Name
Type trimf
Params
Help
Close
Ready


Membership Function Editor: Untitled3
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FIS Variables
Error
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Membership function plots
plot points:
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-BF
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output variable "Force"
Current Variable
Name Force
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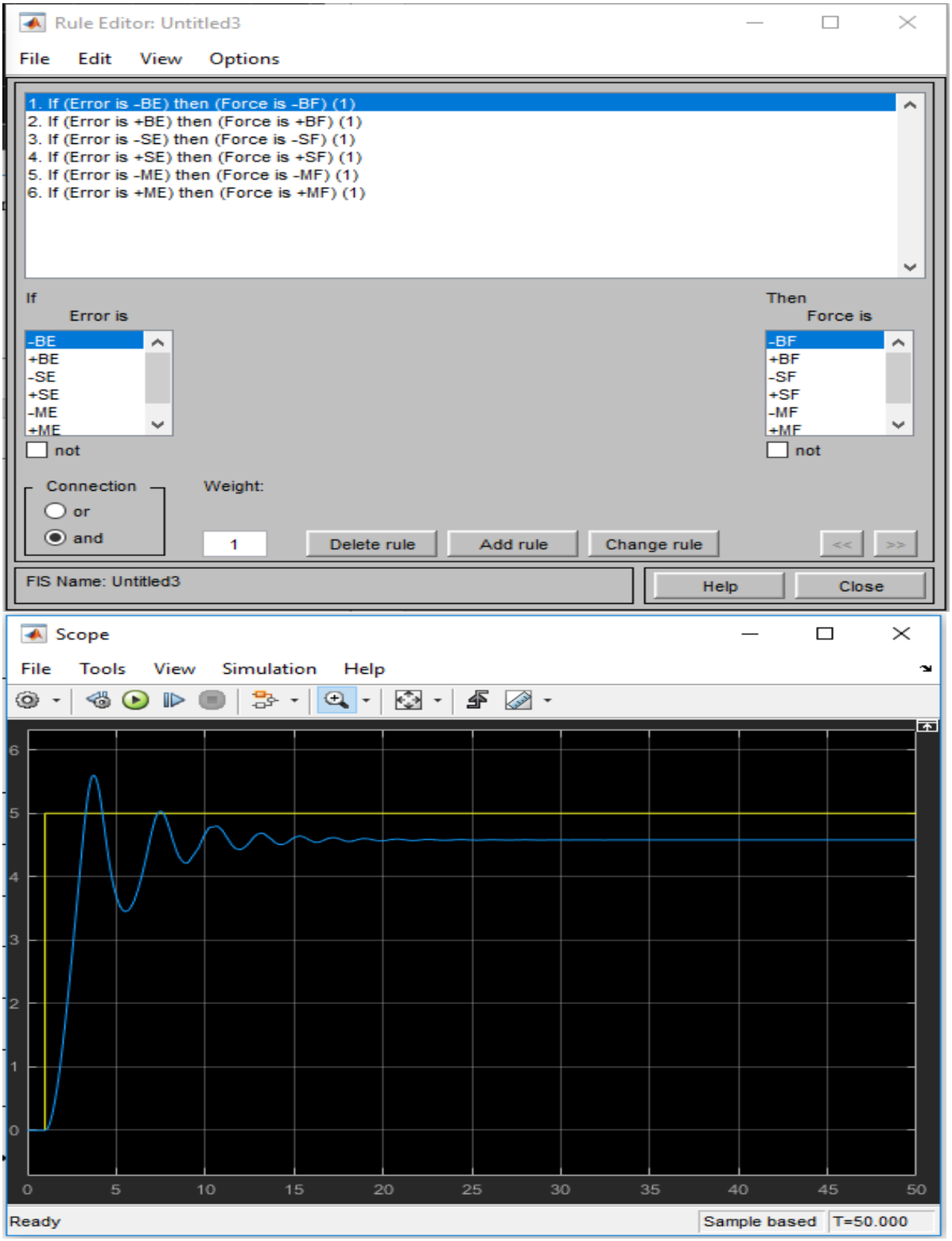
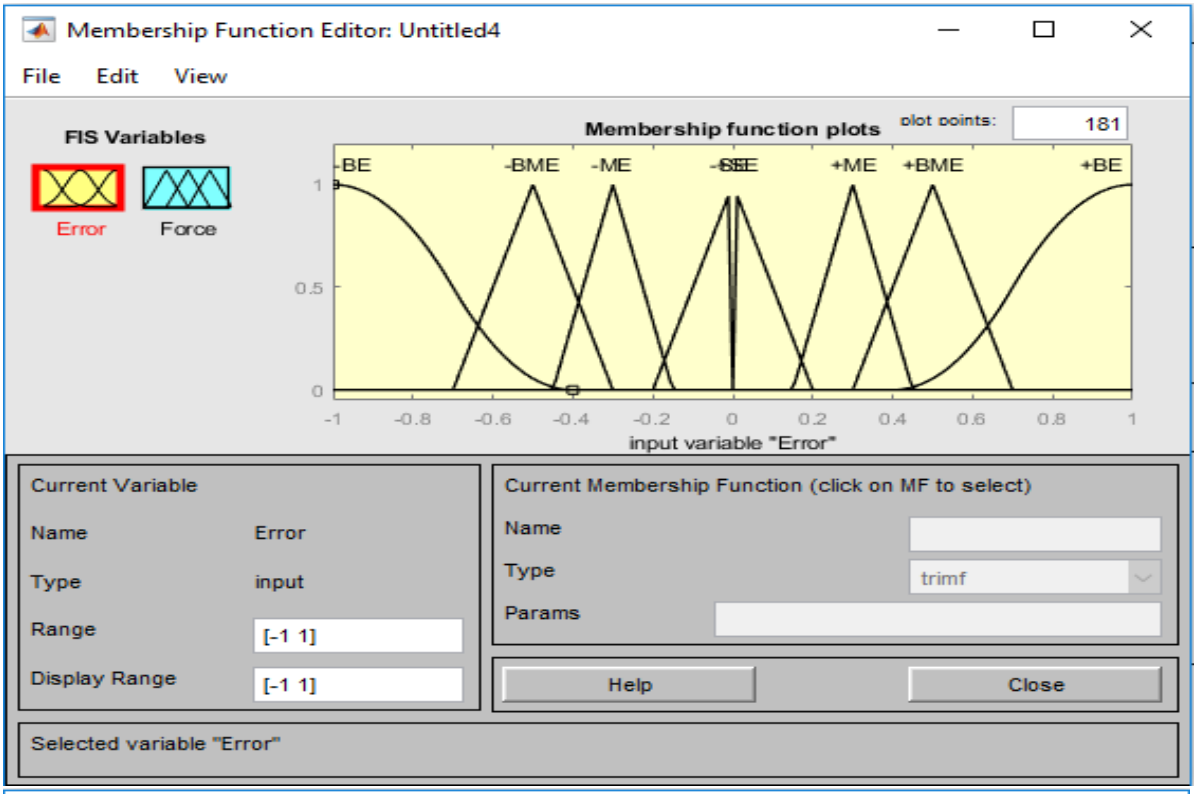
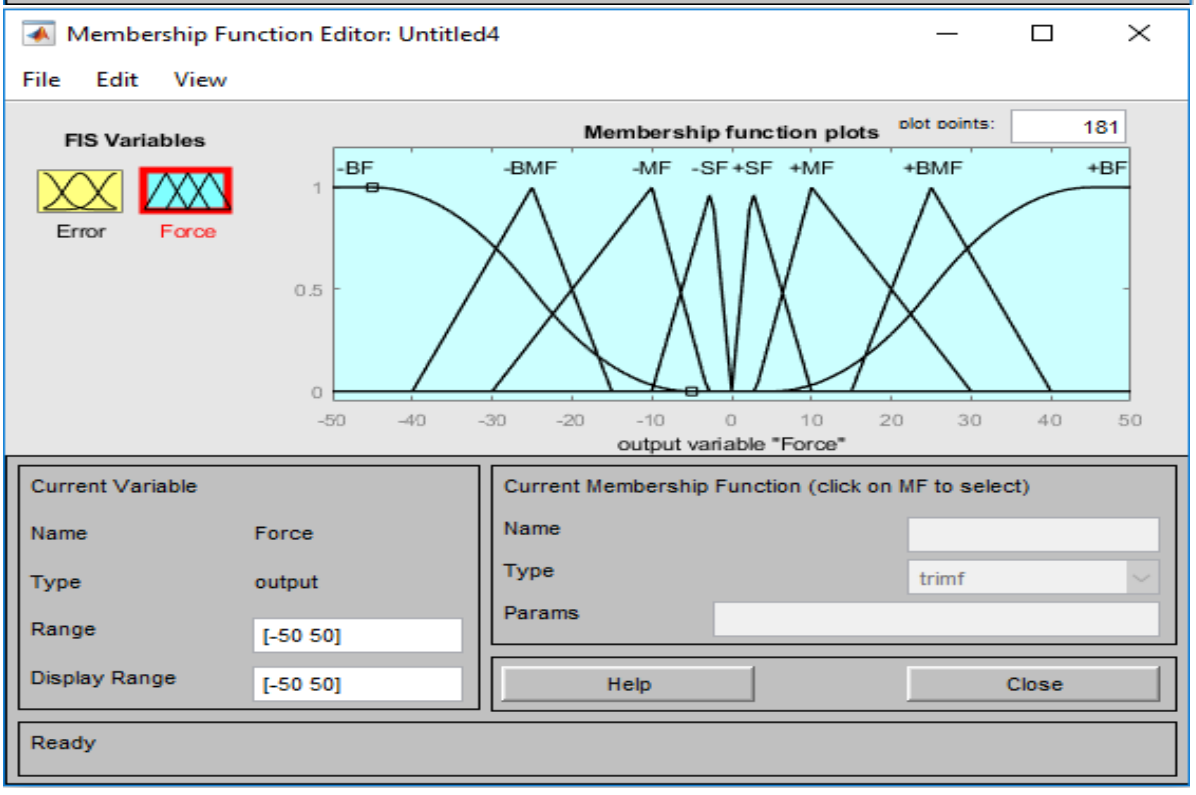
Range [-50 50]
Display Range [-50 50]
Current Membership Function (click on MF to select)
Name
Type trimf
Params
Help
Close
Selected variable "Force"

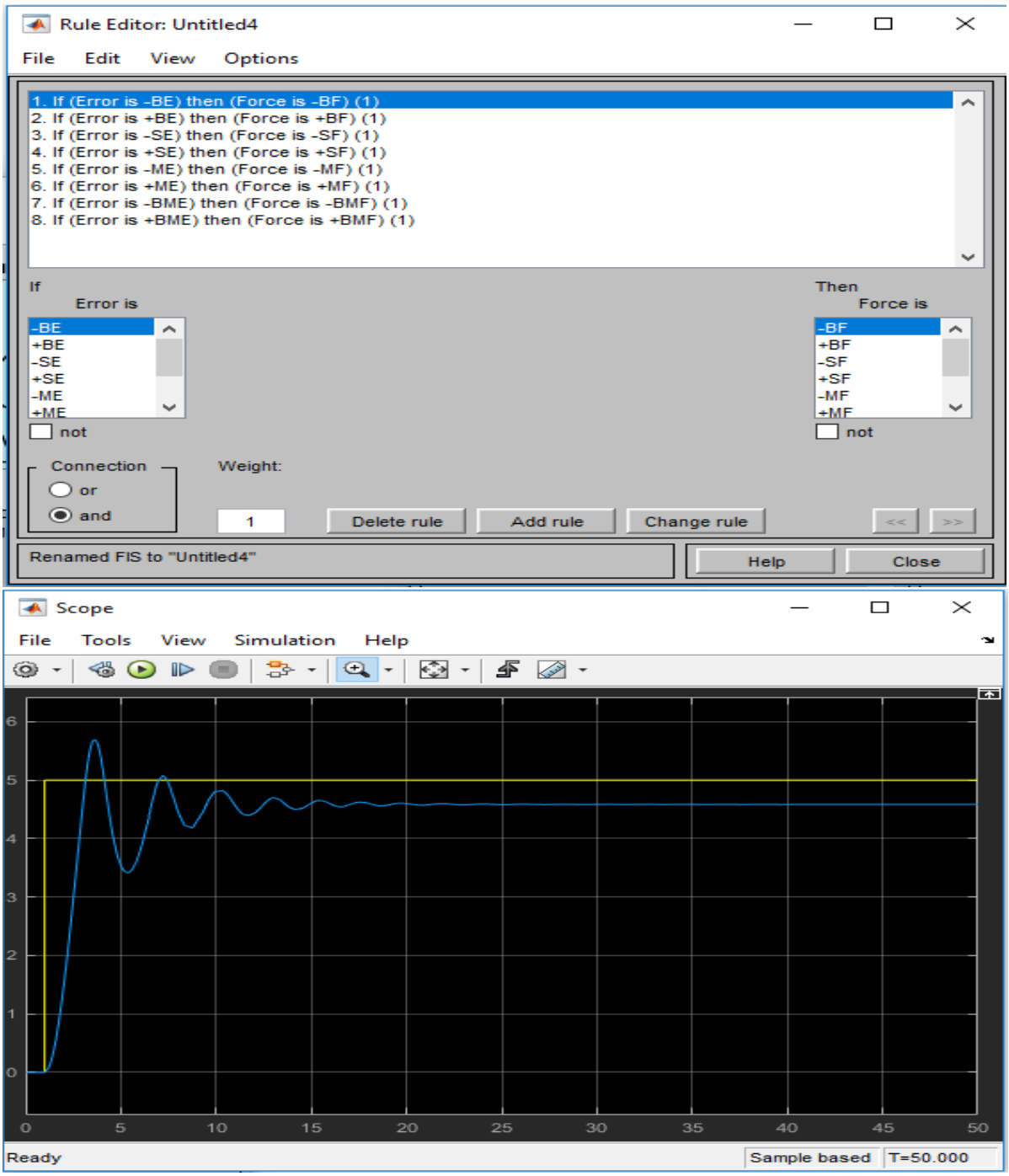


- So, the output responses show us that the error is small. We will try to decrease it in the fourth trial as we will show.

Fourth Trial :-

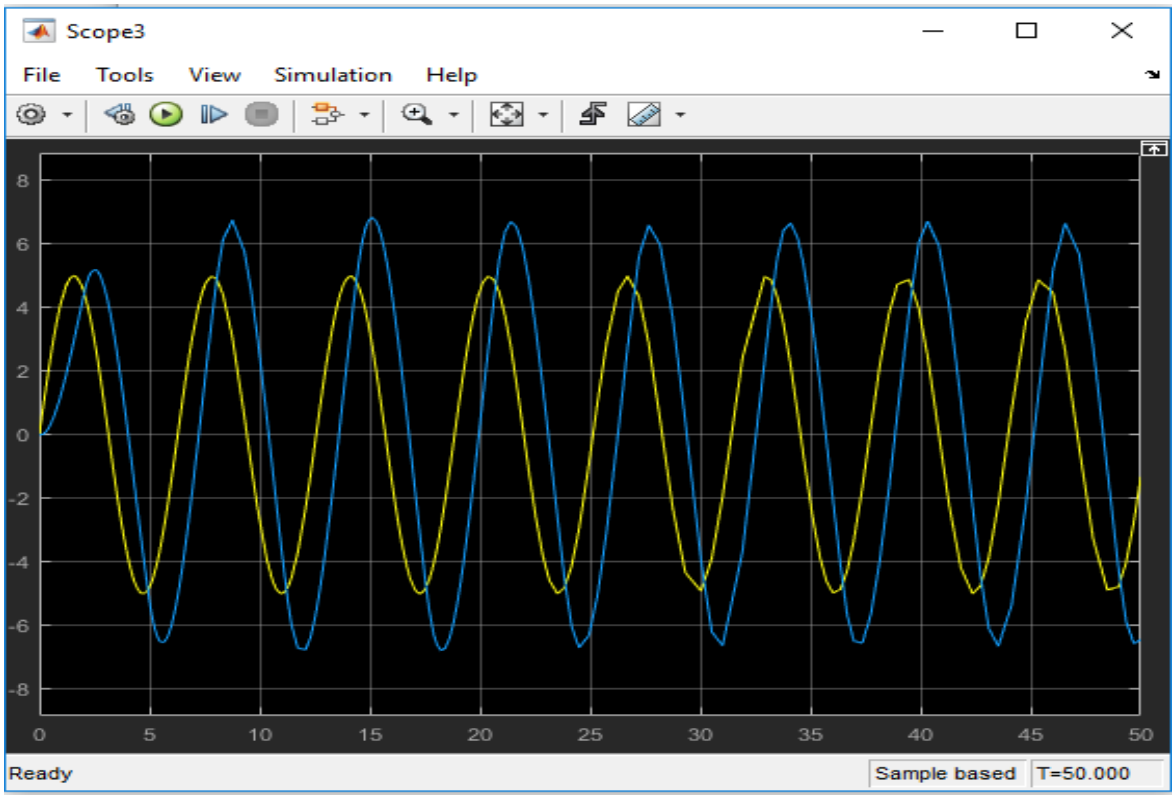






- We can add more than input to decrease error but we stop at here

- Time response for output of the sine input :-



- Time response for output of the ramp input :-