Chapter 2. MathScript and Formula Node

2.1a. What is MathScript

MathScript is math-oriented, text-based computing language to address tasks mathematic calculation:

- Most suitable for Mathematic calculation.
- Matrix based data type system.
- Can create a custom function.
- Same Syntax with Matlab.

2.2 Accessing the MathScript Window

Getting Start – Tools -- MathScript Window

2.1b. Formula Node Variable Definition

https://www.ni.com/docs/en-US/bundle/labview/page/formula-node-syntax.html

- **floating-point-type:**

float float32 float64

- **integer-type:**

int int8 int16 int32 uInt8 uInt16 uInt32

2.3 MathScript Windows:

- Command window : for command line input
- Output Window: shows the resulting output
- Script Editor window: for loading, saving, editing, and running

- Variables window: shows variables, dimensions, and type
- Command History window: shows historical commands and scripts.

Example 1

Input a=1+2 in the Script Editor window, and run this code. Check each window.

2.4 View Data in a Variety Formats

2.4.1 View in Variable window

Input :

t=[0: 0.1: 10];

y=sin(t);

View y in the Graph or XY Graph format.

View y or t in the Numeric format

2.4.2 You can also use MathScript “Plot”

Input :

```
t=[0: 0.1: 10];
y=sin(t);
Plot(t, y);
```

Input :

```
t=[0: 0.1: 10];
X=cos(t);
y=sin(t);
Plot(x, y);
```

2.5 MathScript Help

In the Command Window input:

- help classes: provide a list of all MathScript classes of function.
- help function: provide help for a particular MathScript function.

A Summary of MathScript Functions

- Plot (2D and 3D)
- Digital Signal Processing (DSP)
- Curve Fitting & Interpolation
- Ordinary Differential Equation (ODE) Solves
- Polynomial Operations
- Linear Algebra
- Matrix Operations
- Vector Operations
- Probability and Statistics
- Optimization
- Basic Functions
- Advanced Functions
- Trigonometric Functions
- Boolean and Bit operations
- Dada Acquisition
- Others

2.6 Syntax

1. Scalar Operation

```
>> 16+3

>> x=16+3

>>  x=16+3;

>> display(x);
```

```
>> 16-3

>>16/3

>>16*3
```

2. Creating Matrices and Vectors

Vector:

```
>>A=[1;2;3]

>>B=[1 -2  7]

>> B=[1,-2,7]
```

Matrix:

```
>> C=[-1 2 0; 4 10 -2; 1 0 6]

>>C=[-1,2,0;4,10,0;1,0,6]
```

3. Creating Vector

```
>>t=1:10;

>>t=1:0.5:10
```

4. Access individual elements of a vector or matrix

```
>>C=[-1 2 0;4 10 -2;1 0 6]
>>C(2,3)
>>F=C(2,3)

>> C(2,:)
>>C(:,3)
>> C([2 3], [1 2])
```

5. Calling Functions

```
>> help linspace

>>G=linspace(1,10,13)


>>Help abs
>>A=-3
>>B=abs(A)
```

6. Assigning data types to variables

```
>>a=sin(3*pi/2)

>>a='temperature'
```

7. Using complex numbers

```
>>a=2+3j
>>a=2+3i
>>b=3+4i
>>c=a+b
```

8. Matrix operations

```
>>K=[-1 2 0;4 10 -2;1 0 6]
>>L=[1 0 0;0 1 0;0 0 1]
>>K+L
>>K*L
>>L.*K
```

```
>>a=[1 2;3 4]
>>b=a^-1
>>c=a*b
```

9. Logical Express

```
>>a=2
>>b=3
>>a==b
>>a~=b
```

```
>>a=2
>>b=2
>>a==b
>>a~=b
```

10. Adding comments

```
>>% In this MathScript, the inputs are x and y
>>% and the output is Z
>>z=x+y     % z is the addition of x and y
```

11. Control flow structure (For Script)

Case-Switch Syntax:

```
switch expression
case expression
statement, ... , statement
...
otherwise
statement, ... , statement
end
```

Script Example :

```
color = 'green';
switch color
case 'green'
disp('color is green');
case 'red'
disp('color is red');
otherwise
disp('color is neither green nor red')
end
```

For Loop Syntax:

```
for variable = expression
    statement1,
    ....
    ....
    statement,
end
```

Script Example:

```
A = 1
for X = 1:1:10
    A = A+1
end
```

If-Else Syntax:

```
for variable = expression
    statement1,
    ....
    ....
    statementn,
end
```

Script Example

```
 A = 1
for X = 1:1:10
    A = A+1
end
```

If-Else Syntax:

```
if expression
    statement, ... , statement
elseif expression
    statement, ... , statement
else
    statement, ... , statement
end
```

Script Example:

```
b = 10;
if b == 1
    c = 3
else
    c = 4
end
```

While Loop Syntax:

```
while expression
    statement1
    ....
    ....
    statementn
end
```

Script Example:

```
A = 1
X = 1
while X<10,
    A = A+1,
    X = X+1,
end
```

2.7 MathScript Node (Formula Node)

MathScript Node is scripts node that can be used in VI as a node function. It is a text-base code.

MathScript can be found at:

Programming>>Structure palette

Or Mathematics>>Scripts & Formulas.

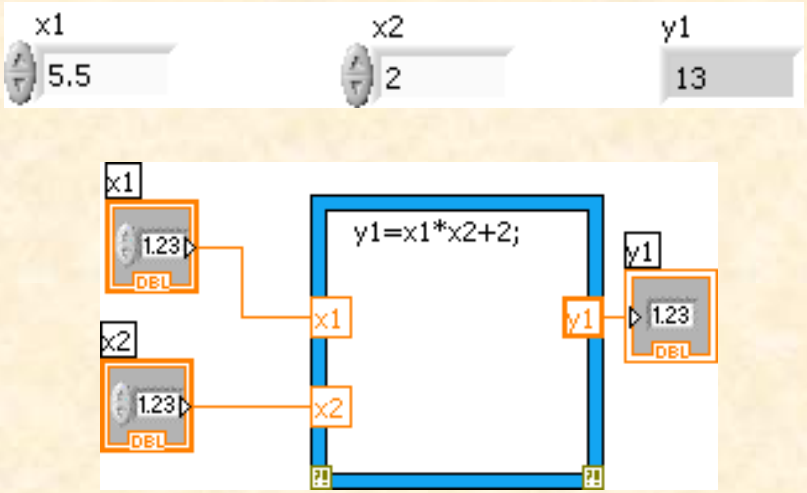


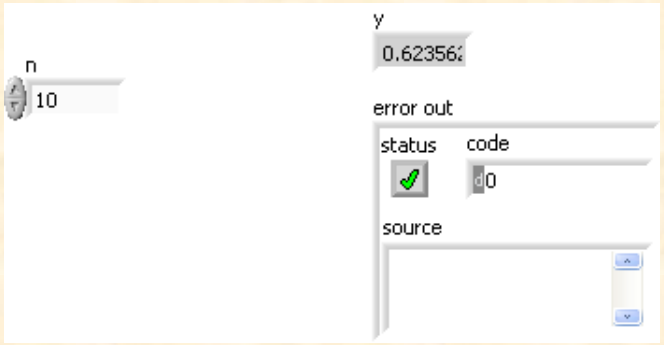
Figure 1. A MathScript Node.

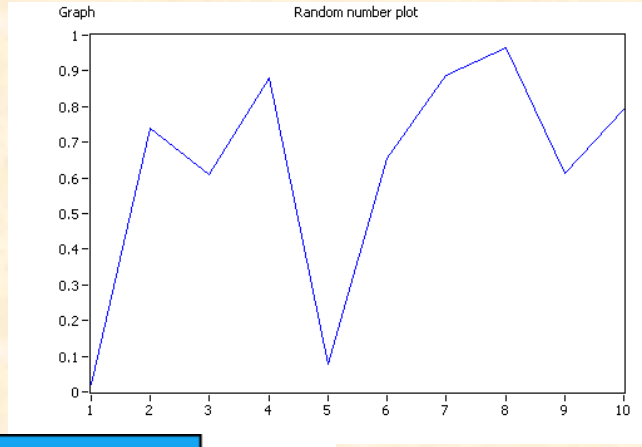
Procedure to create a MathScript Node:

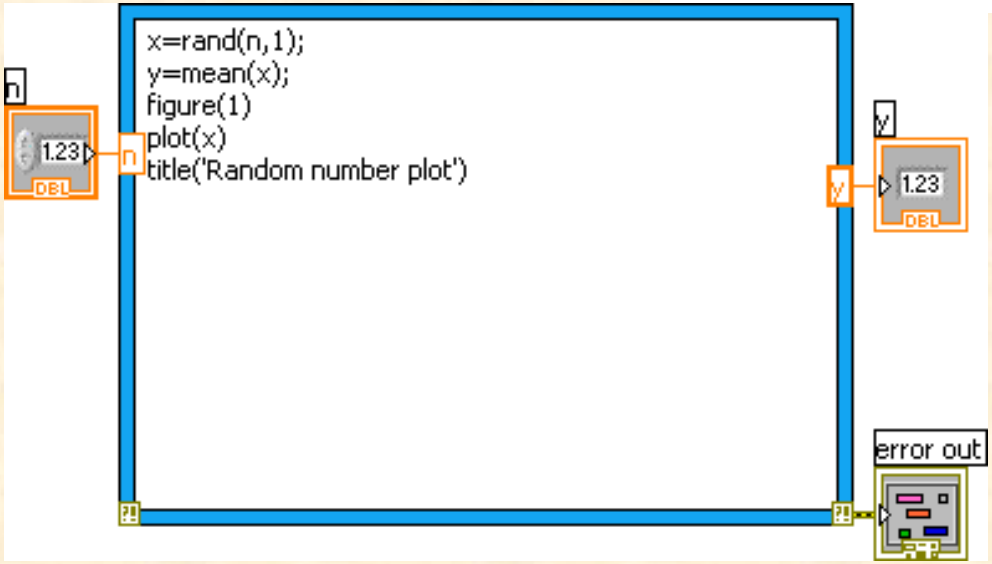
1) Place a MathScript Node on the block diagram
2) Right click the board to add input or output
3) Add the names of the variables.

Assignment 1

Write the following MathScript Node to generate, plot, and analyze a sequence of a random number.







Assignment 2

For $A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 2 & 5 \\ 1 & 2 & 7 \end{bmatrix}$, $B = \begin{bmatrix} -1 & 0 & 2 \\ 3 & 1 & 4 \\ 2 & 1 & 3 \end{bmatrix}$

Write a Script code to calculate Matrix C:

C=A*B, E=A*C, if d=1;

C= A^{-1}, E=A*C, if d is not equal to 1;

Assignment 3 (MathScript)

Open a new VI and place a MathScript Node on the block diagram. Create a numeric input on the MathScript Node frame and name it w. Generate the sine wave y=sin(w*t) within the node, where t starting at t=0 and ending at t=10. Replace the frequency with the variable w an the input controlled from a from panel knob. Create 2 output on the MathScript Node frame name t and y, where t is the time history and y is the sine function associated with t. Plot the sine wave using an XY Graph.

Assignment 4 (Formula Node)

Open a new VI and place a MathScript Node on the block diagram. Create a numeric input on the MathScript Node frame and name it w. Generate the sine wave y=sin(w*t) within the node, where t starting at t=0 and ending at t=10. Replace the frequency with the variable w an the input controlled from a from panel knob. Create 2 output on the MathScript Node frame name t and y, where t is the time history and y is the sine function associated with t. Plot the sine wave using an XY Graph.

Assignment 5 (Formula Node)

Construct a VI that solves the quadratic formula to find the real roots of the equation:

$$ax^2 + bx + c = 0$$

Where x is the variable. a, b and c are constant. The real solution of the equation is given by

$$x_1 = (-b + \sqrt{b^2 - 4ac})/(2a) \text{ and } x_1 = (-b - \sqrt{b^2 - 4ac})/(2a)$$

Construct a Mathscript Formula Node to computer the above roots. There are should 2 outputs for the 2 roots, and 3 inputs for the constant a, b and c. Once you finish the code, using this Formula Node to create a SubVI.

Call your subVI in a new VI.