Software Packages Lab Sr Kamran Usman BSMth_7

Lab 14_Sep_2023

Reset

```
clc % Clear Command Window
clear all % Remove all items form the workspace
```

Variable_Case sensitive

```
% Variables are case sensitive
x = 2; fprintf('Variable x ='),disp(x)
```

```
Variable x =     2
```

```
X = [1;2]; fprintf('Matrix X = \n'), disp(X)
```

```
Matrix X =
     1
     2
```

```
class_x = class(x); fprintf('Class of x is '),disp(class_x)
```

```
Class of x is double
```

Operators

```
chk_temp = x < 40
```

```
chk_temp = logical
   1
```

```
        % Relational Operators
... <=, >=, ==, ~ =

    ... Logical Operators
... 0 False,  1 True

    ... Conditional Operators
... ~ Not , & and, | or
```

If ...elseif ... else

```
if (x >=10)
    x = x + 1;
    fprintf('x is greater than or equal to 10'), disp(x)
end
```

```
if (x >=10)
    x = x + 1;
    fprintf('x is greater than or equal to 10.   x  ='), disp(x)
else
    x = x - 1;
    fprintf('x is not greater than or equal to 10.  x  ='),disp(x)
end
```

```
x is not greater than or equal to 10.  x  =     1
```

```
if (x >=10)
    x = x + 1;
    fprintf('x is greater than or equal to 10.   x  ='), disp(x)
elseif (x >= 20)
    x = x - 1;
    fprintf('x is greater than or equal to 20.  x  ='),disp(x)
else
    x
    fprintf('x is neither >= 10 nor >= 20,\n  x ='),disp(x)
end
```

```
x = 1
x is neither >= 10 nor >= 20,
  x =     1
```

Matrics Operations

```
y = [12, 10, -3] % row matrix
```

```
y = 1×3
    12    10    -3
```

```
z = [12; 10; -3] % column matrix
```

```
z = 3×1
    12
    10
    -3
```

```
Y = [1, 2, 3; 4, 5, 6; 7, 8, 9] % square matrix
```

```
Y = 3×3
     1     2     3
     4     5     6
     7     8     9
```

Slicing

```
Y33 = Y(3, 1:3), Y122 = Y(1:2, 2)
```

```
Y33 = 1×3
     7     8     9
Y122 = 2×1
     2
     5
```

```
siz_Y33 = size(Y33), siz_Y122 = size(Y122)
```

```
siz_Y33 = 1×2
     1     3
siz_Y122 = 1×2
     2     1
```

Concatination

```
A = [1, 2; 3, 4]
```

```
A = 2×2
     1     2
     3     4
```

```
a_cat = [A, 2*A; 3*A, 4*A], siz_acat = size(a_cat)
```

```
a_cat = 4×4
     1     2     2     4
     3     4     6     8
     3     6     4     8
     9    12    12    16
siz_acat = 1×2
     4     4
```

```
A = [0 1 2;
    1 0 -1;
    2 -1 0];

disp('Matrix A='), disp(A)
```

```
Matrix A=
     0     1     2
     1     0    -1
     2    -1     0
```

Augmented form

A x = b

[A, b]

```
A = [1, 3; 5, 4]
```

```
A = 2×2
     1     3
     5     4
```

```
b = [1; 5]
```

```
b = 2×1
     1
     5
```

```
aug = [A, b]
```

```
aug = 2×3
```

```
     1     3     1
     5     4     5
```

Solution for the system of equations

```
x = inv(A)*b %inverse of Matrix -> inv(A)
```

```
x = 2×1
    1.0000
   -0.0000
```

OR

```
x = A\b
```

```
x = 2×1
    1.0000
   -0.0000
```

matrix multiplication operation criteria

```
x = A*b % M-1 num of colums = M2 num of rows
```

```
x = 2×1
    16
    25
```

Row vector to diagonal matrix

```
s = [1 3 5 6]
```

```
s = 1×4
     1     3     5     6
```

```
Mtx_s = diag(s)
```

```
Mtx_s = 4×4
     1     0     0     0
     0     3     0     0
     0     0     5     0
     0     0     0     6
```

Diagonal matrix to column vector

```
dg_Mtx_s = diag(Mtx_s),
```

```
dg_Mtx_s = 4×1
     1
     3
     5
     6
```

```
len_dg_Mtx_s = length(dg_Mtx_s), len_Mtx_s = length(Mtx_s)
```

```
len_dg_Mtx_s = 4
len_Mtx_s = 4
```

Built-in funcitons

- zeros ones eye rand
- diag size rank length
- det inv

```
zer = zeros(3,3), ons = ones(2), ey = eye(3), rnd = rand % range between [0, 1]
```

```
zer = 3×3
     0     0     0
     0     0     0
     0     0     0
ons = 2×2
     1     1
     1     1
ey = 3×3
     1     0     0
     0     1     0
     0     0     1
rnd = 0.9649
```

```
dig_ons = diag(ons), siz_dig = size(dig_ons), rnk_dig = rank(dig_ons)
```

```
dig_ons = 2×1
     1
     1
siz_dig = 1×2
     2     1
rnk_dig = 1
```

```
len_dig = length(dig_ons), dt_ey = det(ey), in_dig = inv(eye)
```

```
len_dig = 2
dt_ey = 1
in_dig = 1
```

Other built-in functions

- abs sin cos acos
- deg2rad exp log log10
- round ceil floor

```
ab = abs(-3) , sn30 = sin(30) , cs45 = cos(45), acs = acos(45)
```

```
ab = 3
sn30 = -0.9880
cs45 = 0.5253
acs = 0.0000 + 4.4997i
```

```
deg2rad(cs45)
```

```
ans = 0.0092
```

```
ex = exp(30), lg = log(30), log_10 = log10(30)
```

```
ex = 1.0686e+13
lg = 3.4012
log_10 = 1.4771
```

```
rund_off = round(log_10), cil_log_10 = ceil(log_10), flr_log10 = floor(log_10)
```

```
rund_off = 1
cil_log_10 = 2
flr_log10 = 1
```

Eigen values and eigen vectors

$A\,v\; =\; \lambda\,v$

$$\begin{aligned} A &= \text{matrix} \\ v &= \text{eigen vector} \\ \lambda &= \text{eigen value} \end{aligned}$$

$$(A - \lambda\, I)v \;=\; 0 \qquad\qquad \det(A - \lambda\, I) = 0$$

eigen vector staying on its on span during the linear transformation

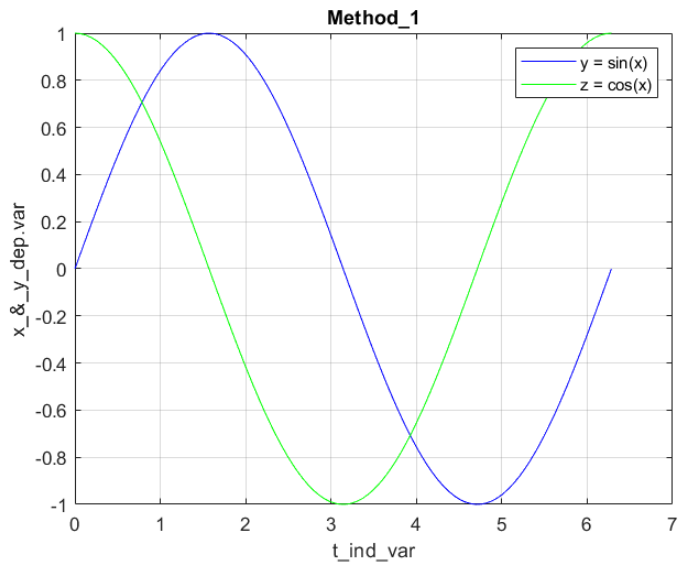
```
% determinent & inverse argument* must be square
eg_A = eig(A);
disp('Eigenvalues in column instead of diagonal'); disp(eg_A)
```

```
Eigenvalues in column instead of diagonal
   -1.6533
    6.6533
```

Lab 21_Sep_2023

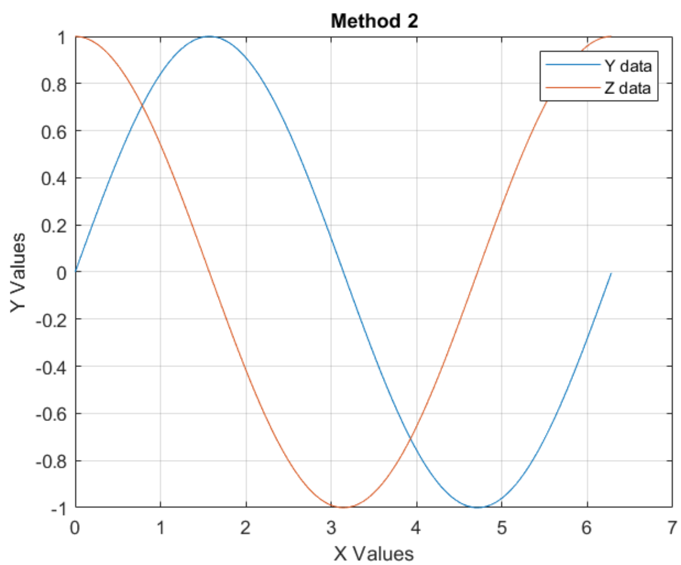
Ploting Method 1

```
clc, clear all
x = linspace(0, 2*pi, 100);
% x = 0:0.01:2*pi;

y = sin(x);
z = cos(x);

plot(x, y, 'b')
hold on
plot(x, z, 'g')

title Method\_1
xlabel t\_ind\_var
ylabel x\_&\_y\_dep.var
legend('y = sin(x)', 'z = cos(x)')
grid on

hold off
```



Ploting Method 2

```
x = 0:0.01:2*pi;
y = sin(x);
z = cos(x);

figure
plot(x,y,x,z);

xlabel 'X Values';
ylabel 'Y Values';
title 'Method 2';
legend ('Y data','Z data');
grid on
```



Piecewise function

$$\{y, 0 \le t \le 1\}$$
$$\left\{\frac{1}{t}, 1 \le t \le 6\right\}$$

Piecewise plot method 1

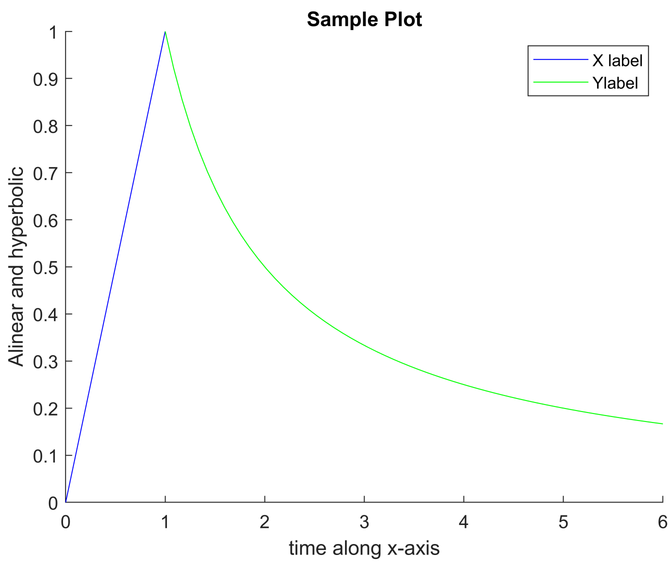
```
clear all, close all
t1 = linspace(0, 1, 10) % from 0 to 1 with linearly spaced vector with 10 points
```

```
t1 = 1×10
         0    0.1111    0.2222    0.3333    0.4444    0.5556    0.6667    0.7778 ⋯
```

```
% t1 = 0:0.1:1 % 0 with increment 0.1 to 1

t2 = linspace(1, 6, 60) % from 1 to 6 with linearly spaced vector with 60 points
```

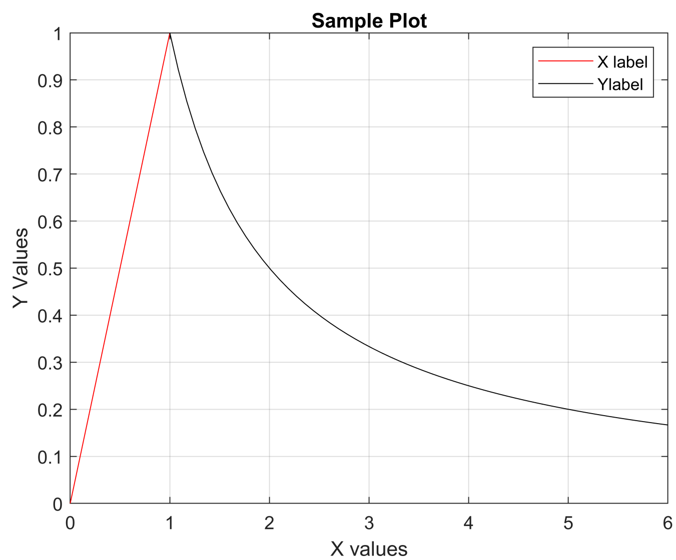
```
t2 = 1×60
    1.0000    1.0847    1.1695    1.2542    1.3390    1.4237    1.5085    1.5932 ⋯
```

```
% t2 = 1:0.0847:6 % form 1 with increment of 0.0847 to 6

y = t1;
z = 1./t2;
hold on
plot(t1,y,'b')
plot(t2,z,'g')

% Sr typed it without prenthesis
xlabel 'time along x-axis'
ylabel('Alinear and hyperbolic')
title 'Sample Plot'
legend('X label','Ylabel')
hold off
```



Piecewise plot method 2

```
t1=linspace(0,1,10);
t2=linspace(1,6,60);
y=t1;
z=1./t2;
plot(t1,y,'r',t2,z,'k');
xlabel 'X values';
ylabel 'Y Values';
title 'Sample Plot'
legend('X label','Ylabel')
grid on
```

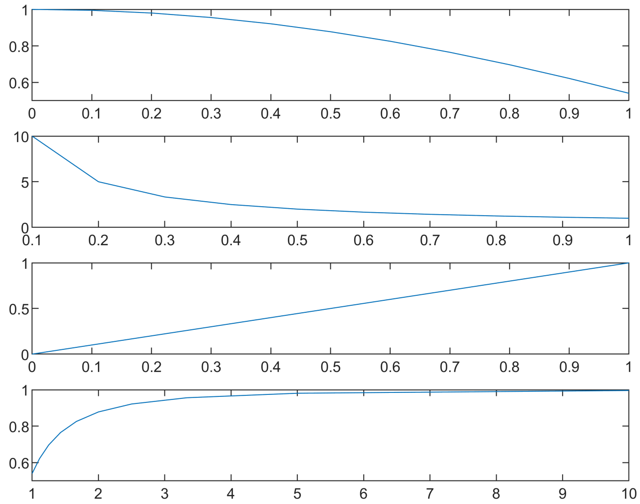


Subploting

```
% Syntax:
% subplot(rows, columns, index)
clear all, close all
t = 0:0.1:1;
y = cos(t)
```

```
y = 1×11
    1.0000    0.9950    0.9801    0.9553    0.9211    0.8776    0.8253    0.7648 ⋯
```

```
z=1./t;
figure
subplot(4,1,1)
plot(t,y)

subplot(4,1,2)
plot(t,z)

subplot(4,1,3)
plot(t,t)

subplot(4,1,4)
plot(z,y)
```



Importing/Exporting Data

Load & Save

```
% Store data into an excel sheet
filename = 'file.xlsx';
A = {'muhammad','arslan';8,6};
sheet = 1;
xlRange = 'A1';
xlswrite(filename,A,sheet,xlRange)

% Copy data from an excel sheet
x = xlsread("file.xlsx");
```

Write matrix A to data.xls and fit elements of A in A2:C4

```
filename = 'data.xlsx'
```

```
filename =
'data.xlsx'
```

```
A = rand(4);
sheet = 1;
xlRange = 'A2:C4'
```

```
xlRange =
'A2:C4'
```

```
xlswrite(filename,A,sheet,xlRange)
```

Writing onto a text file

```
x = xlsread("data.xlsx")
```

```
x = 3×3
    0.6160    0.5853    0.7572
    0.4733    0.5497    0.7537
    0.3517    0.9172    0.3804
```

```
x = num2str(x)
```

```
x = 3×31 char array
    '0.61604     0.58526      0.7572'
    '0.47329     0.54972     0.75373'
    '0.35166     0.91719     0.38045'
```

```
fid = fopen('mystuff.txt','w')
```

```
fid = 3
```

```
count = fwrite(fid, x);

fclose(fid);
```

Read from a text file

```
fid = fopen('mystuff.txt','r')
```

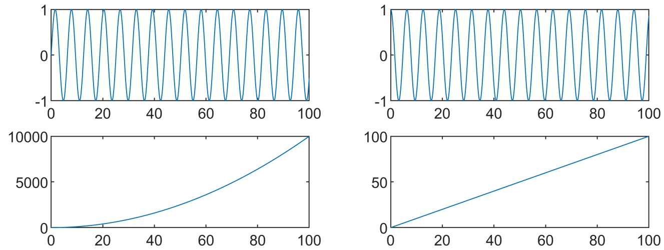
```
fid = 4
```

```
fclose(fid);
```

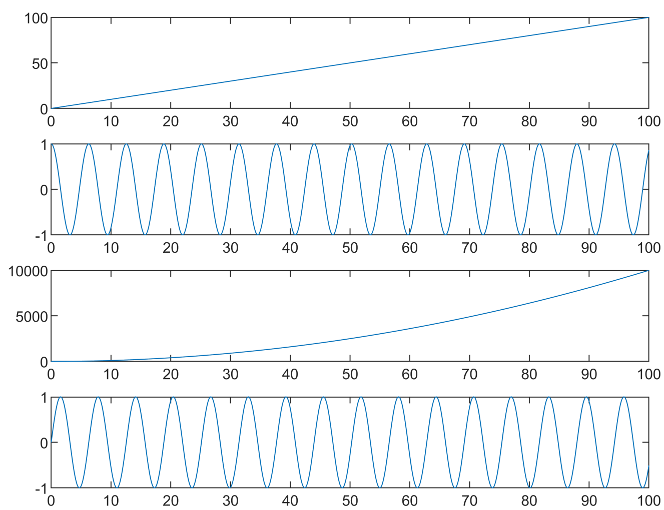
Lab 28_Sep_2023

Revision Subplot & File Manipulation

```
clear all, close all
x = 0:0.1:100;
y = sin(x);
z = cos(x);
w = x.^2;
v = x;

subplot(4,2,1)
plot(x,y)
subplot(4,2,2)
plot(x,z)
subplot(4,2,3)
plot(x,w)
subplot(4,2,4)
plot(x,v)
```




```
figure
subplot(4,1,1)
plot(x,v)
subplot(4,1,2)
plot(x,z)
subplot(4,1,3)
plot(x,w)
subplot(4,1,4)
plot(x,y)
```




```
%% File Manuplation
% Store data from xlsx into a variable
% xl_rd = xlsread('heart.xlsx')
%%
%
A = rand(3);
```

```
xl_wt = xlswrite('testdata.xlsx', A);
% In Matlab Desktop Version this xlswrite will create xls file
% But Online version it'll create csv
% range will show error inside the cell if not present
A = [4 5 5 5; 3 5 2 6; 2 5 2 5];
xl_wt = xlswrite('data1.xls', A, 'A2:C4');
%%
% Assignmet Practice
b = linspace(1,20,25)
```

```
b = 1×25
    1.0000    1.7917    2.5833    3.3750    4.1667    4.9583    5.7500    6.5417 ⋯
```

```
xl_wt = xlswrite('data2.xls', b, 'b4:b7')
```

```
xl_wt = logical
   1
```

```


x_rd = xlsread('data2.xls'); disp(x_rd)
```

```
     1
     1
     1
     1
```

Lab 5_Oct_2023

Functions

```
h = @ones;
a = h()
```

```
a = 1
```

Function with one input

```
% function [m,s] = stat(x)
%  n = length(x);
%  m = sum(x)/n;
%  s = sqrt(sum((x-m).^2/n));
% end

% values = [12.7, 45.4, 98.9, 26.6, 53.1];
% [ave,stdev] = stat(values)
```

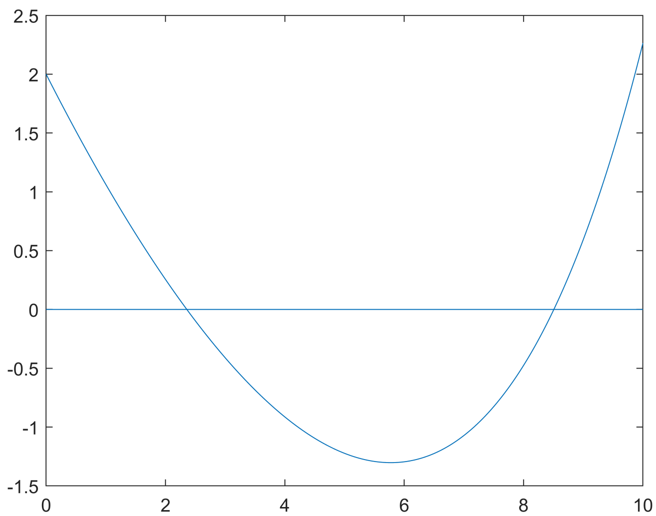
Function with four inputs

```
% function y = computeAverage(x1,x2,x3,x4)
% y = (x1+x2+x3+x4)/4;
% end

%% Computation
```

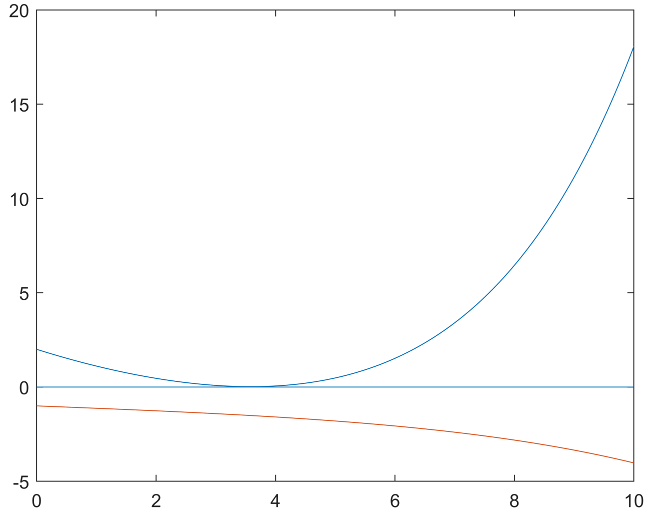
```
% f = computeAverage(2,3,6,7)
```

Ploting of a funciton

```
clc; clear all; close all;
f = @(x) 2*cosh(x/4)-x;
% a=0;
% b=6;
% tol=10e-6;
x = linspace(0,10,1000);
figure(1)
plot(x, f(x));
hold on
line([0 10], [0 0])

hold off
```




```
% 2.figure 2
clc; clear all; close all;
f = @(x) 2.*cosh(x/3)-x;
df= @(x) (-0.5).*sinh(x/4)-1;
x = linspace(0,10,1000);

figure(2)
plot(x, f(x),x,df(x));
hold on
line([0 10], [0 0])
hold off
```



Functions for sum of natural numbers

Sum of Arithmetic Series (common difference)

- “S” is the sum of the arithmetic sequence,
- “a” as the first term,
- “d” the common difference between the terms,
- “n” is the total number of terms in the sequence and

```
% function sum_arithmetic_series(n,a,d)
%  S = n/2*(2*a+(n-1)*d)
% end
```

- “L” is the last term of the sequence.

```
% function last_term(n,a,L)
%  S = n/2*(a+L)
% end
```

Sum of natural numbers (n)

Save this inside the working dir

Save this at the end of you script file

```
% function x = sum1(n)
% x = n*(n+1)/2;
% end

% function [t, x, y, z] = lorenz_odes45(tspan, x0, y0, z0)
% % lorenz_odes45: Solves the Lorenz equation using the odes45 method.
```

```
%
% % Inputs:
% % tspan: The time span over which to solve the equation.
% % x0, y0, z0: The initial conditions.
%
% % Outputs:
% % t: A vector of time points.
% % x, y, z: Vectors of the solutions.
%
% % Define the Lorenz function.
% lorenz = @(t, y) [y(2) - y(1); y(1) - y(2) - y(1) * y(3); y(1) * y(2) - y(3)];
%
% % Solve the equation using odes45.
% [t, y] = odes45(lorenz, tspan, [x0; y0; z0]);
%
% % Extract the solutions for x, y, and z.
% x = y(:, 1);
% y = y(:, 2);
% z = y(:, 3);
% end
```

Assignment 01

Solving Odinary Differential Equation

```
Eqn = 'Dy=x*y^2+y'
```

```
Eqn =
'Dy=x*y^2+y'
```

```
Init='y(0)=1';
x = dsolve(Eqn,Init,'x')
```

```
Warning: Support of character vectors and strings will be removed in a future release. Use sym objects to
 define differential equations instead.
x =
```

$$-\frac{1}{x-1}$$

Manipulation with txt File

Writing onto a txt file

```
% fprintf% for reading txt file
% Analyze the text file manipulation
x = 100*rand(8,1);
fileID = fopen('nums1.txt','w');
fprintf(fileID,'%4.4f\n',x);
fclose(fileID);
```

To create a new file

```
fid = fopen('Asgn_01.txt','w')
```

```
fid = 8
```

```
fclose(fid);
```

To delete a text file

```
% delete('Asgn_01.txt')
% force_delete('Asgn_01.txt')
```

To rename a text file

```
% movefile('Asgn_01.txt', 'Asgn.txt');
```

To store data inside the text file

```
data = 'My name is Arslan'
```

```
data =
'My name is Arslan'
```

```

fid = fopen('Asgn_01.txt', 'w');
fwrite(fid, data);
fclose(fid);
```

`fprintf` functions to read and write formatted data to a text file

data in the cell array `data` to a text file

```
fid = fopen('new_file.txt', 'w');
fprintf(fid, '%s %s\n', data);
fclose(fid);
```

Quiz_01

Sum of n_terms

Q: Write a snippet 'for' loop for taking sum of n terms using matlab language

```
% Prompt the user for the number of terms
n = input('Enter the number of terms: ');
% Initialize the sum
sum = 0;
% Iterate through the terms and add them to the sum
for i = 1:n
 sum = sum + i;
end
% Display the sum
disp(['The sum of the first ' n ' terms is ' num2str(sum) '.'])

% function x = sum0(n)
```

```
% % """Calculates the sum of the first n terms.
% % Args:
% % n: The number of terms.
% % Returns:
% % The sum of the first n terms.
% % """
%  x = 0;
%  for i = 1:n
%  x = x + i;
%  end
% end

% sum0(15)
```

Lab 12_Oct_2023

Solve the second & higher order odes and plot the solution

$y'' + 8y' + 2y = cos(x)$

$y(0) = 0$
$y'(0) = 1$

```
clear all, close all
Eqn2 = 'D2y + 8*Dy + 2*y = cos(x)'
```

```
Eqn2 =
'D2y + 8*Dy + 2*y = cos(x)'
```

```
Inits = "y(0) = 0, y'(0) = 1" % how to put initial condition with y'(0) = 1
```

```
Inits =
"y(0) = 0, y'(0) = 1"
```

```
y = dsolve(Eqn2, Inits, 'x')
```

```
Warning: Support of character vectors and strings will be removed in a future release. Use sym objects to
 define differential equations instead.
y =
```

$$\frac{\sqrt{14}\ \sigma_2\ (7\ \sqrt{14}-27)}{28\ \sigma_3} - \frac{\sqrt{14}\ e^{4\,x+\sqrt{14}\,x}\,\sigma_1\ (\sin(x)+\cos(x)\ (\sqrt{14}+4))}{28\ \left((\sqrt{14}+4)^2+1\right)} + \frac{\sqrt{14}\ e^{4\,x-\sqrt{14}\,x}\,\sigma_2\ (\sin(x)-\cos(}{28\ \left((\sqrt{14}-4)^2+\right.}$$

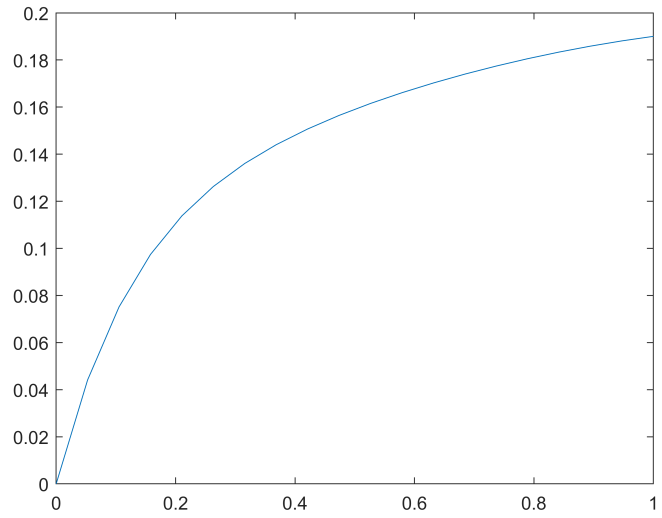
where

$$\sigma_1 = e^{-x\ (\sqrt{14}+4)}$$

$$\sigma_2 = e^{x\ (\sqrt{14}-4)}$$

$$\sigma_3 = 8\ \sqrt{14} - 31$$

```
x = linspace(0,1,20);
z = eval(vectorize(y));
plot(x, z)
```



Lab 19_Oct_2023

Solve the differential equation

$$\frac{\mathrm{dx}}{\mathrm{dt}} = -r\,x$$

Method_1

```
dsolve('Dx=-r*x','t')
```

```
Warning: Support of character vectors and strings will be removed in a future release. Use sym objects to
 define differential equations instead.
```

ans = $C_1\,\mathrm{e}^{-r\,t}$

$$\frac{\mathrm{dy}}{\mathrm{dx}} = x\,y$$

```
dsolve('Dy=x*y','x')
```

```
Warning: Support of character vectors and strings will be removed in a future release. Use sym objects to
 define differential equations instead.
```

ans =

$$C_1\,\mathrm{e}^{\frac{x^2}{2}}$$

Method_2

```
Eqn1 = 'Dy = x*y';
y = dsolve(Eqn1,'x')
```

```
Warning: Support of character vectors and strings will be removed in a future release. Use sym objects to
 define differential equations instead.
y =
```

$$C_1 \mathrm{e}^{\frac{x^2}{2}}$$

Consider the initial value problem

$$\frac{\mathrm{dy}}{\mathrm{dx}} = \mathrm{xy},\ y(1) = 1$$

M_1

```
Eqn1 = 'Dy = x*y';
y = dsolve(Eqn1, 'y(1)=1', 'x')
```

```
Warning: Support of character vectors and strings will be removed in a future release. Use sym objects to
 define differential equations instead.
y =
```

$$\mathrm{e}^{-\frac{1}{2}} \mathrm{e}^{\frac{x^2}{2}}$$

M_2

```
clear all, close all
Eqn1 = 'Dy = x*y';
Init = 'y(1) = 1'
```

```
Init =
'y(1) = 1'
```

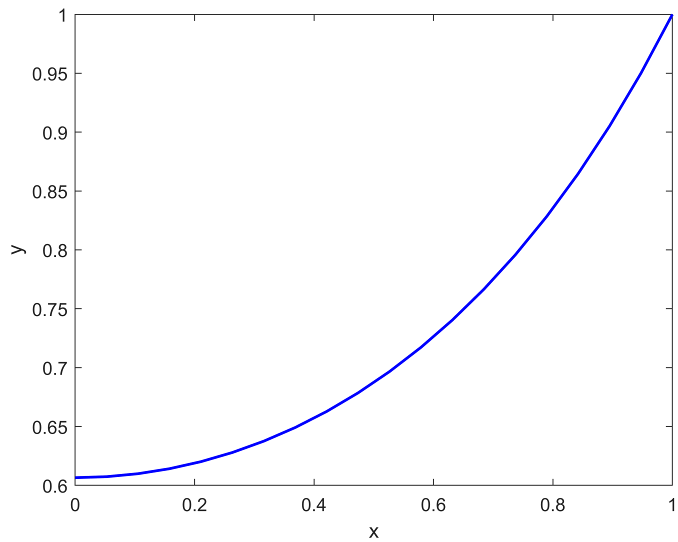
```
y = dsolve(Eqn1, Init, 'x')
```

```
Warning: Support of character vectors and strings will be removed in a future release. Use sym objects to
 define differential equations instead.
y =
```

$$\mathrm{e}^{-\frac{1}{2}} \mathrm{e}^{\frac{x^2}{2}}$$

Plot

```
x = linspace(0,1,20);
z = eval(vectorize(y));
plot(x,z, 'b','linewidth',1.5)
xlabel ('x')
ylabel ('y')
```



System of Multiple Odenary Differential Equations

Analytical / Explicit Solution

$$dx/dt = x + 2y - z$$

$$dy/dt = x + z$$

$$dz/dt = 4x - 4y + 5z$$

```
clear all, close all
[x, y, z] = dsolve('Dx = x + 2*y - z',... %3dots show continuity
    'Dy = x + z', 'Dz = 4*x -4*y + 5*z', 't')
```

```
Warning: Support of character vectors and strings will be removed in a future release. Use sym objects to
 define differential equations instead.
x =
```

$$-\frac{C_1\,e^t}{2} - \frac{C_2\,e^{2\,t}}{2} - \frac{C_3\,e^{3\,t}}{4}$$

y =

$$\frac{C_1\,e^t}{2} + \frac{C_2\,e^{2\,t}}{4} + \frac{C_3\,e^{3\,t}}{4}$$

z = $C_1\,e^t + C_2\,e^{2\,t} + C_3\,e^{3\,t}$

Solve it using initial conditon

$x(0) = 1$
$y(0) = 2$
$z(0) = 3$

```
A = 'Dx = x + 2*y - z'
```

A =

```
'Dx = x + 2*y - z'
```

```
B = 'Dy = x + z'
```

```
B =
'Dy = x + z'
```

```
C = 'Dz = 4*x -4*y + 5*z'
```

```
C =
'Dz = 4*x -4*y + 5*z'
```

```
Inits = 'x(0)=1, y(0)=2, z(0)=3'
```

```
Inits =
'x(0)=1, y(0)=2, z(0)=3'
```

```
[x, y, z] = dsolve(A, B, C, Inits, 't')
```

```
Warning: Support of character vectors and strings will be removed in a future release. Use sym objects to
 define differential equations instead.
```

x =

$$6\,e^{2t} - \frac{5\,e^{3t}}{2} - \frac{5\,e^{t}}{2}$$

y =

$$\frac{5\,e^{3t}}{2} - 3\,e^{2t} + \frac{5\,e^{t}}{2}$$

z = $10\,e^{3t} - 12\,e^{2t} + 5\,e^{t}$

Finally plot the solution

```
t = linspace(0,0.5,25);
xx = eval(vectorize(x))
```

```
xx = 1×25
    1.0000    1.0414    1.0822    1.1221    1.1608    1.1982    1.2338    1.2674 ···
```

```
yy = eval(vectorize(y))
```

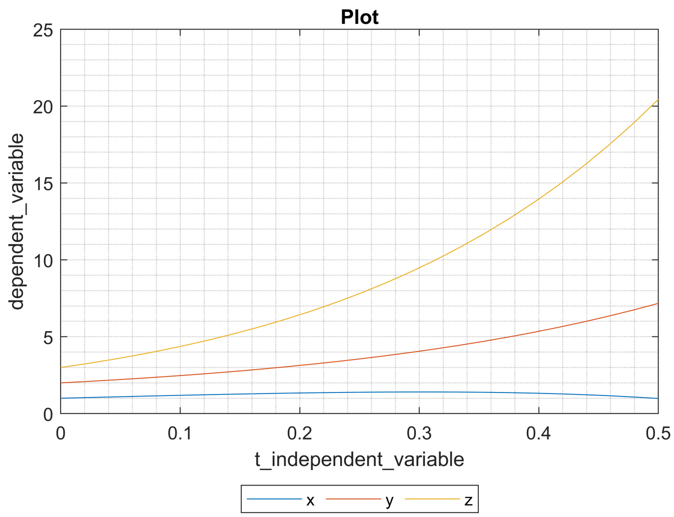
```
yy = 1×25
    2.0000    2.0862    2.1785    2.2774    2.3832    2.4967    2.6183    2.7486 ···
```

```
zz = eval(vectorize(z))
```

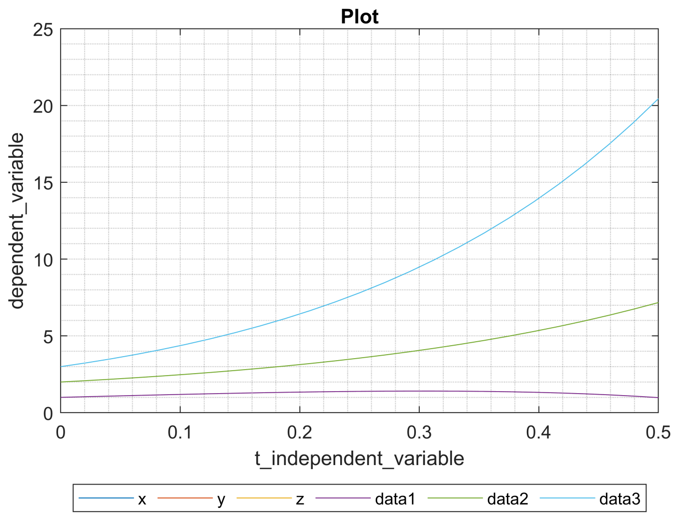
```
zz = 1×25
    3.0000    3.2396    3.5014    3.7870    4.0984    4.4378    4.8074    5.2094 ···
```

```
plot(t, xx, t, yy, t,zz)

title Plot
xlabel t\_independent\_variable
ylabel dependent\_variable
legend x y z Location bestoutside Orientation horizontal
grid minor
```

```
xlim('auto')
ylim('auto')
```




```
hold on
plot(t,xx);
plot(t,yy);
plot(t,zz);
hold off
```




```
% Exact_Solution: Maple/Mathematica
% Numerical_Solution: Matlab
% * Newton Raphson Method - 2nd Order accurate
```

1st order numerical solutions

$$dy/dx = xy^2 + y$$
$$y(0) = 1$$

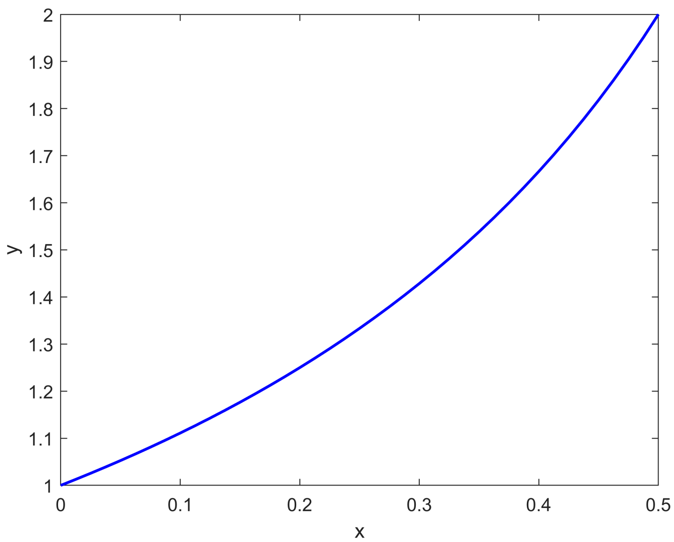
```
% y' = f(x,y)
f = @(x,y) x*y^2 + y % Give space b/w fun handle and expression
```

```
f = function_handle with value:
    @(x,y)x*y^2+y
```

```
[x,y] = ode45(f,[0 0.5],1)
```

```
x = 41×1
         0
    0.0125
    0.0250
    0.0375
    0.0500
    0.0625
    0.0750
    0.0875
    0.1000
    0.1125
      ⋮

y = 41×1
    1.0000
    1.0127
    1.0256
    1.0390
    1.0526
    1.0667
    1.0811
    1.0959
    1.1111
    1.1268
      ⋮
```

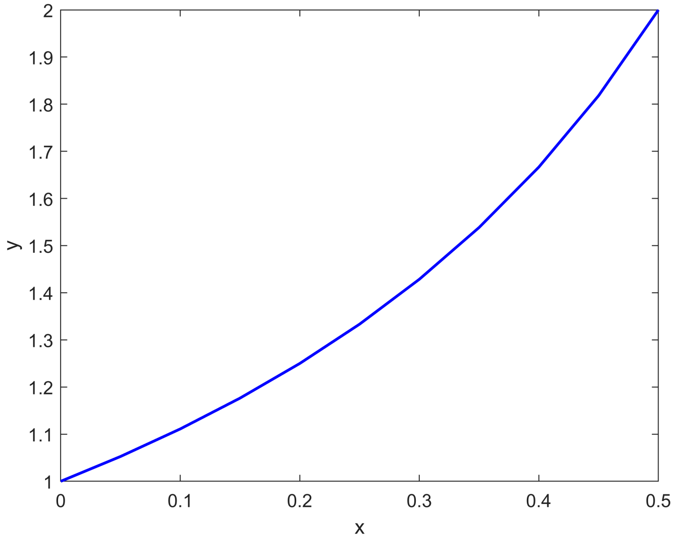
```
% Eular Method
% Runge Kuta Method More accurate for approximation | iteration
% RK2_ode23 | RK4_ode45 | ode113

plot(x,y,'b','linewidth',1.5)

xlabel('x')
ylabel('y')
```




```
[l,m] = ode23(f,[0 0.5],1)
```

```
l = 11×1
         0
    0.0500
    0.1000
    0.1500
    0.2000
    0.2500
    0.3000
    0.3500
    0.4000
    0.4500
      ⋮

m = 11×1
    1.0000
    1.0526
    1.1111
    1.1765
    1.2500
    1.3333
    1.4286
    1.5384
    1.6666
    1.8181
      ⋮
```

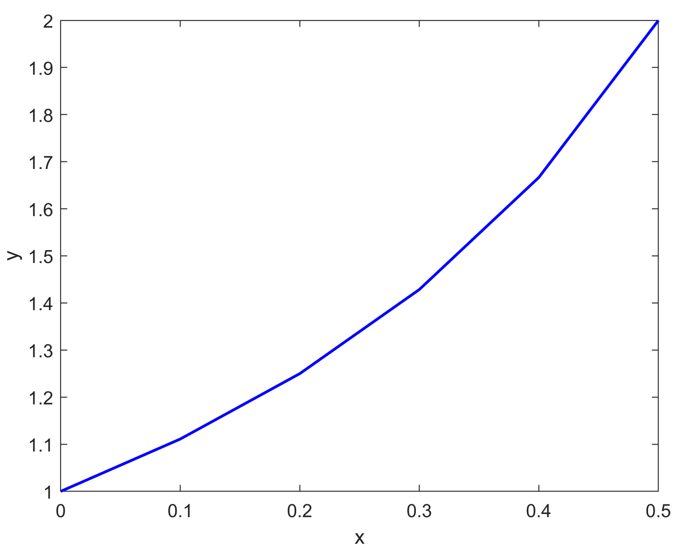
```
plot(l,m,'b','linewidth',1.5)

xlabel x
ylabel y
```




```
[n,o] = ode23(f,[0:0.1:0.5],1)
```

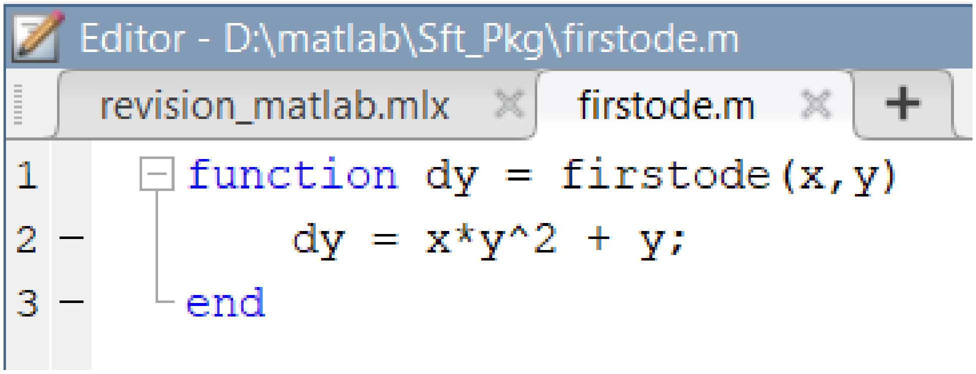
```
n = 6×1
         0
    0.1000
    0.2000
    0.3000
    0.4000
    0.5000
o = 6×1
    1.0000
    1.1111
    1.2500
    1.4286
    1.6666
    1.9999
```

```
plot(n,o,'b','linewidth',1.5)
xlabel x
ylabel y
```



Alternate Method

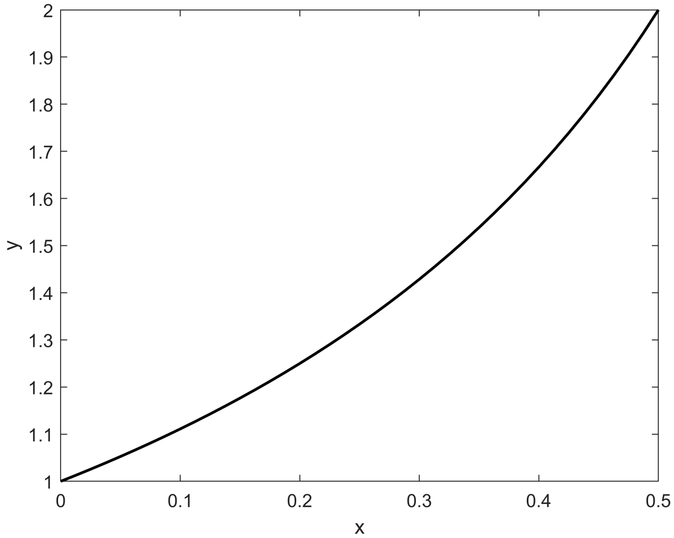
First order equations with (Function) M-File




```
% function dy = firstode(x,y)
% dy = x*y^2 + y;
% end

% Call the function
xspan = [0 0.5];
y0 = 1;
[x,y] = ode45(@firstode,xspan,y0)
```

```
x = 41×1
         0
    0.0125
    0.0250
    0.0375
    0.0500
    0.0625
    0.0750
    0.0875
    0.1000
    0.1125
      ⋮

y = 41×1
    1.0000
    1.0127
    1.0256
    1.0390
    1.0526
    1.0667
    1.0811
    1.0959
    1.1111
    1.1268
      ⋮
```

```
plot(x,y,'k','linewidth',1.5)
xlabel x
ylabel y
```



Lab 26_Oct_2023

Example: Solve the system of Lorenz equations

$$dx/dt = \sigma(y - x)$$

$$dy/dt = \rho x - y - xz$$

$$dz/dt = xy - \beta z$$

Take ,

$$\sigma = 10, \beta = \frac{8}{3}, \rho = 28$$

$$x(0) = -8, y = 8, z(0) = 27$$

Editor - D:\matlab\Sft_Pkg\lab26_oct\lorenz.m

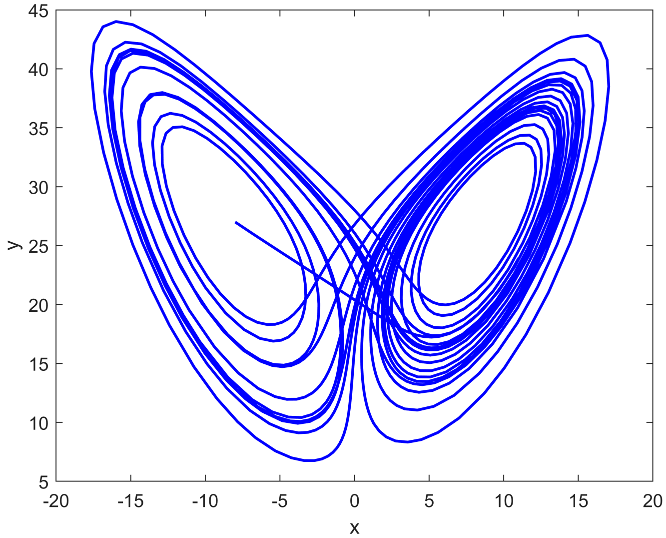
revision_matlab.mlx | lorenz.m

```
function dx = lorenz(t,x)
% function [ output_args ] = untitled2( input_args )
%UNTITLED2 Summary of this function goes here
%   Detailed explanation goes here

% Predefine given constants
sigma = 10;
beta = 8/3;
rho = 28;

% Initial guess
dx = zeros(3,1)

% dx(1) = x, dx(2) = y, dx(3) = z
dx(1) = sigma *(x(2)-x(1)); % x(1) = x , x(2) = y
dx(2) = rho * x(1)-x(2)-x(1)*x(3);
dx(3) = x(1)*x(2)-beta*x(3);
end
```

```
% function dx = lorenz(t,x)
% sigma = 10;
% beta = 8/3;
% rho = 28;
% dx = zero(3,1)
% dx(1) = sigma *(x(2)-x(1)); % x(1) = x , x(2) = y
% dx(2) = rho * x(1)-x(2)-x(1)*x(3);
% dx(3) = x(1)*x(2)-beta*x(3);
% end

% X = (x, y, z)
% dX = (dx, dy, dz)

x0 = [-8 8 27];
tspan = [0,20]
```

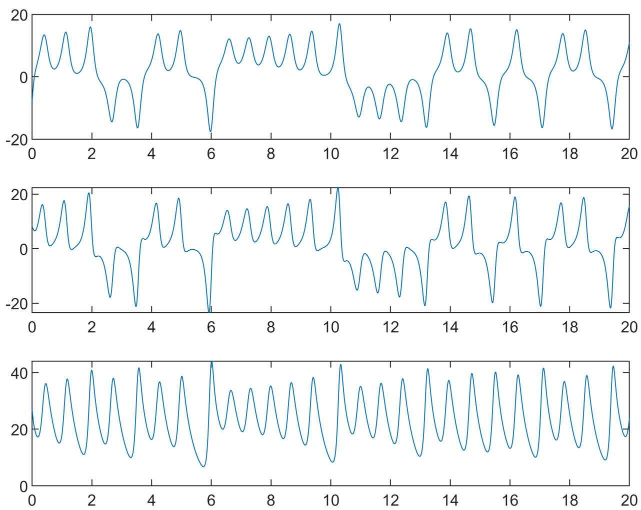
```
tspan = 1×2
     0    20
```

```
[t, x] = ode45(@lorenz, tspan, x0)

plot(x(:,1),x(:,3), 'b', 'linewidth',1.5)
xlabel ('x')
ylabel ('y')
```



Subplotting Lorenz solution

```
subplot (3,1,1)
plot(t,x(:,1))
subplot (3,1,2)
plot(t,x(:,2))
subplot (3,1,3)
plot(t,x(:,3))
```



Assignment_02

Question:

$$dx/dt = \sigma(y - x)$$

$$dy/dt = \rho x - y - xz$$

$$dz/dt = xy - \beta z$$

Initial conditions,

$$x(0) = -8, y(0) = 8, z(0) = 27$$

instead of dx vector use dx, dy, dz and Solve this system of Lorenz Equation

Quiz_02

Statement:

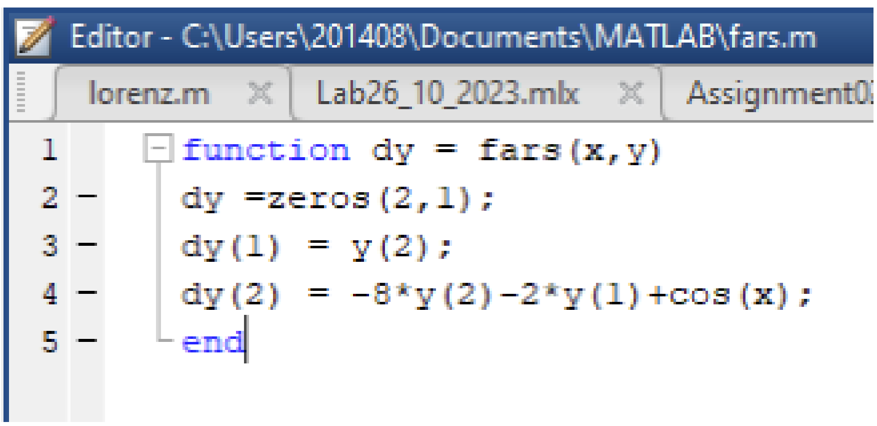
$$y'' + 8y' + 2y = \cos(x)$$

Solve using command ode45 with initial conditions,

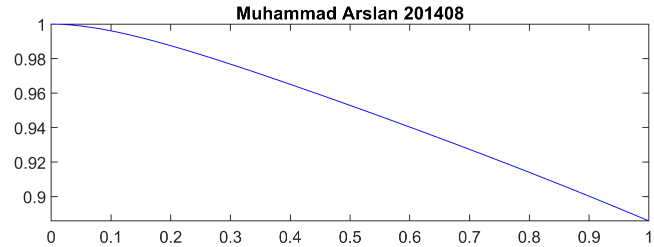
$$y'(0) = 0,\ y(0) = 1$$

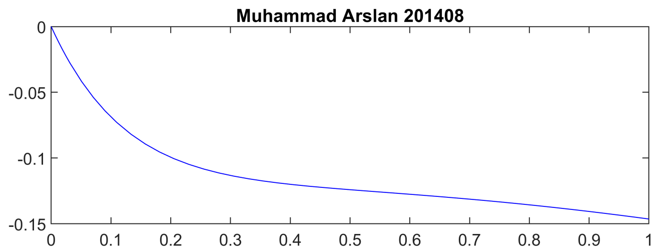
$$\text{xspan} = [0, 1]$$

Share Screenshorts (cmd, plot, mlx)




```
% function dy = fars(x,y)
% dy =zeros(2,1);
% dy(1) = y(2);
% dy(2) = -8*y(2)-2*y(1)+cos(x);
% end

xspan=[0 1];
y0=[1,0];
[x,y]=ode45(@fars,xspan,y0);
plot(y(:,1),y(:,2),'b')
subplot(2,1,1)
plot(x,y(:,1),'b')
title ('Muhammad Arslan 201408');
subplot(2,1,2)
plot(x,y(:,2),'b')
title ('Muhammad Arslan 201408');
```


Muhammad Arslan 201408
1
0.98
0.96
0.94
0.92
0.9
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


Muhammad Arslan 201408
0
-0.05
-0.1
-0.15
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1