Experiment 2

Mean Value Theorem

Interpretation and Visualization

I. Aim

To view the tangent lines to the curve and understand the applicability of Mean Value Theorem using MATLAB

II. Mathematical Background:

Mean Value Theorem: Suppose given function y = f(x) is continuous on a closed interval [a, b] and differentiable on the open interval (a, b). Then there exists **at least one** number c in (a, b) so that:

$$f'(c) = \frac{f(b) - f(a)}{b - a}.$$

Standard equation of tangent line: y = m*x + b

- m is slope
- b is calculated by b = y (at c) – m*c in for loop.

III. MATLAB Code:

Editor - D:\VIT\MATLAB\Refined\mvt.m

mvt.m

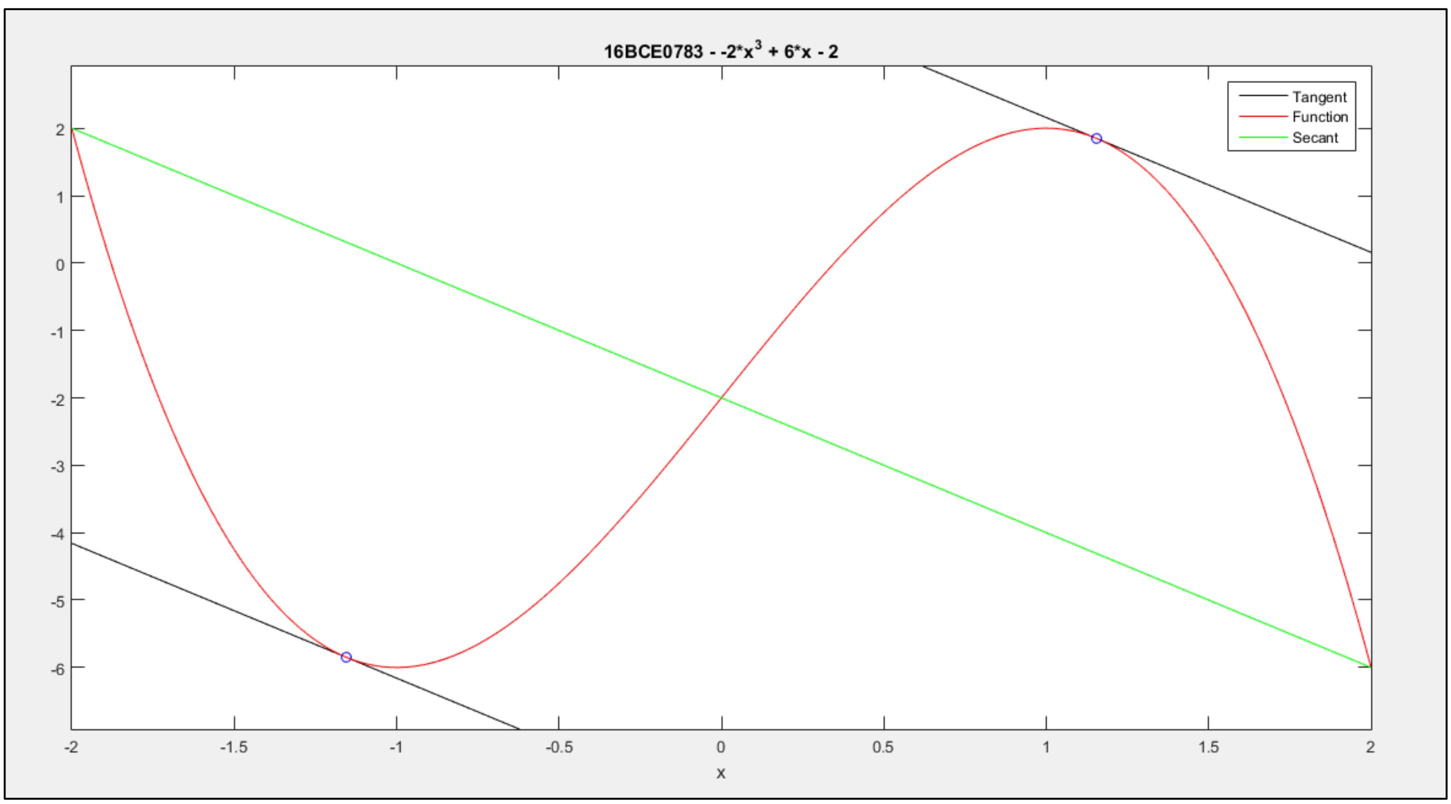
```matlab
syms x c
f = input('Enter the function of x : ');
I = input('Enter the limit : ');
dF = diff(f,x);
dFc = subs(dF,x,c);
fa = subs(f,x,I(1));
fb = subs(f,x,I(2));
lhs = dFc;
rhs = (fb - fa)/(I(2)-I(1));
%c = solve(lhs - rhs,c) will give value of c in symbol, use double
c = double(solve(lhs - rhs,c));
index = find(c>I(1) & c<I(2)); %Finding indices of c in range I(1) and I(2)
c = c(index);
%plot function and secant plot
for i = 1:numel(c)  %number of values of c is numel(c)
    fc = double(subs(f,c(i)));
    m = double(subs(dF,c(i)));
    b = double(subs(f,c(i))-subs(dF,c(i))*c(i));
    tangent = m*x + b;
    h = ezplot(tangent);
    set(h,'Color','black');  % used to set graphic properties
    % set(variable,'property_name','property_value')
    hold on
    g = ezplot(f,[I(1) I(2)]);
    set(g,'Color','red');
    plot([I(1) I(2)],[double(subs(f,I(1))) double(subs(f,I(2)))],'g');
    plot(c(i),fc,'o','MarkerEdgeColor','blue');
    legend('Tangent','Function','Secant');
    title('16BCE0783 - -2*x^3 + 6*x - 2')
end
```

IV. MATLAB I/O :

```
    %plot function and secant plot
for i = 1:numel(c)   %number of values of c is numel(c)
    fc = double(subs(f,c(i)));
    m = double(subs(dF,c(i)));
    b = double(subs(f,c(i))-subs(dF,c(i))*c(i));
```

Command Window

```
>> mvt
Enter the function of x : -2*x^3 + 6*x - 2
Enter the limit : [-2 2]
>>
```



V. Question - Answers:

Q1 Answer:

The range can be changed by using the below commands in ezplot

ezplot(function,[xmin,xmax])

ezplot(function,[xmin,xmax,ymin,ymax])

The graphical properties can be changed using ‘set’ command. Syntax is

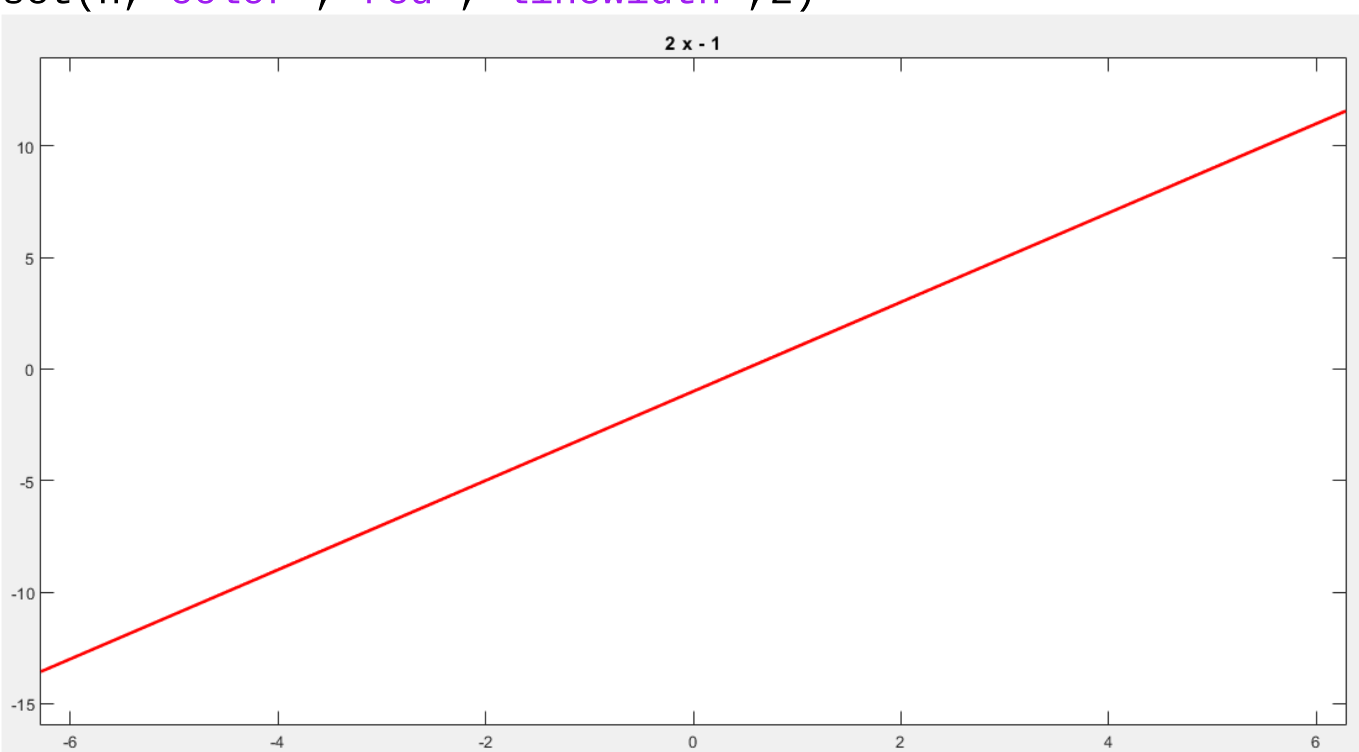
set(variable,'property_name','property_value')

Some examples of property values are:

- marker face color
- marker size
- color
- marker edge color
- linewidth etc.

Example to set color and width of a line plotted by ezplot:

```
syms x
h = ezplot(2*x-1)
set(h,'color','red','linewidth',2)
```



Q2 Answer:

The code written in lab record above will not work for constant functions, i.e. when we are asked to input function of x, if someone enters a constant, the code will not work correctly.

The solve command used in the lab code returns solutions in symbolic form. Hence in place of solve, we can use vpasolve command. What vpasolve does that it solves the equation numerically whereas solve command solves the equation symbolically. For the equations which are not polynomial, MATLAB returns the first numerically solution found.

Q3 Answer:

Editor - D:\VIT\MATLAB\implicit_diff.m

mvt.m | implicit_diff.m

```matlab
syms x y dy
f = input('Enter the implicit function : ');
x0 = input('Enter the value of x-coordinate : ');
y0 = input('Enter the value of y-coordinate : ');
ezplot(f)
% MATLAB doesn't plot function of a function.
f = subs(f,y,'y(x)');
%y = sym('y(x)');
%f = eval(f);
dF = diff(f,x);
% quotes mean string
% MATLAB cannot solve the value of function of x but that function of x can
% be set as a variable and then we can solve for the variable.
dF = subs(dF,'diff(y(x),x)',dy);
dFn = subs(dF, {x,y}, {x0,y0});
m = solve(dFn,dy);  %solve dFn for dy
tangent = y0 + m*(x-x0);
hold on;
h = ezplot(tangent);
set(h,'Color','Black')
title('16BCE0783 - (x^2 + y^2 - 8)')
plot (x0,y0,'*r')
```

Command Window

```
Enter the implicit function : x^2 + y^2 - 8
Enter the value of x-coordinate : 2
Enter the value of y-coordinate : 2
>>
```