AM25M009 - Assignment 5 - Theory Class

```matlab
clc; clear;
close all;

f  = @(x) exp(-2*x) - x;
x0 = 2;

% exact derivative
fprime_exact = -2*exp(-2*x0) - 1;

% step sizes
h_values = 0.5:-0.001:0.05;

fdash_values = zeros(size(h_values));
err_values   = zeros(size(h_values));
fprintf("NOT PRINTING ALL!!\n\n")
fprintf('%8s %15s %15s\n','h','Derivative','Abs_Error');
fprintf('---------------------------------------------\n');

for k = 1:length(h_values)
    h = h_values(k);
    fdash = ( f(x0 + h) - f(x0 - h) ) / (2*h);    % central difference
    err   = abs(fdash - fprime_exact);

    fdash_values(k) = fdash;
    err_values(k)   = err;

    if mod(k,15) == 0
        fprintf('%8.3f %15.8f %15.8e\n', h, fdash, err);
    end
end

% linear plot
figure;
plot(h_values, err_values, 'o-','LineWidth',1.5);
xlabel('Step size h');
ylabel('Absolute error');
title('Central difference derivative: Error vs h');

% log-log
figure;
loglog(h_values, err_values, 'o-','LineWidth',1.5);
xlabel('Step size h (log scale)');
ylabel('Absolute error (log scale)');
title('Central difference derivative: Log-log error plot');
```
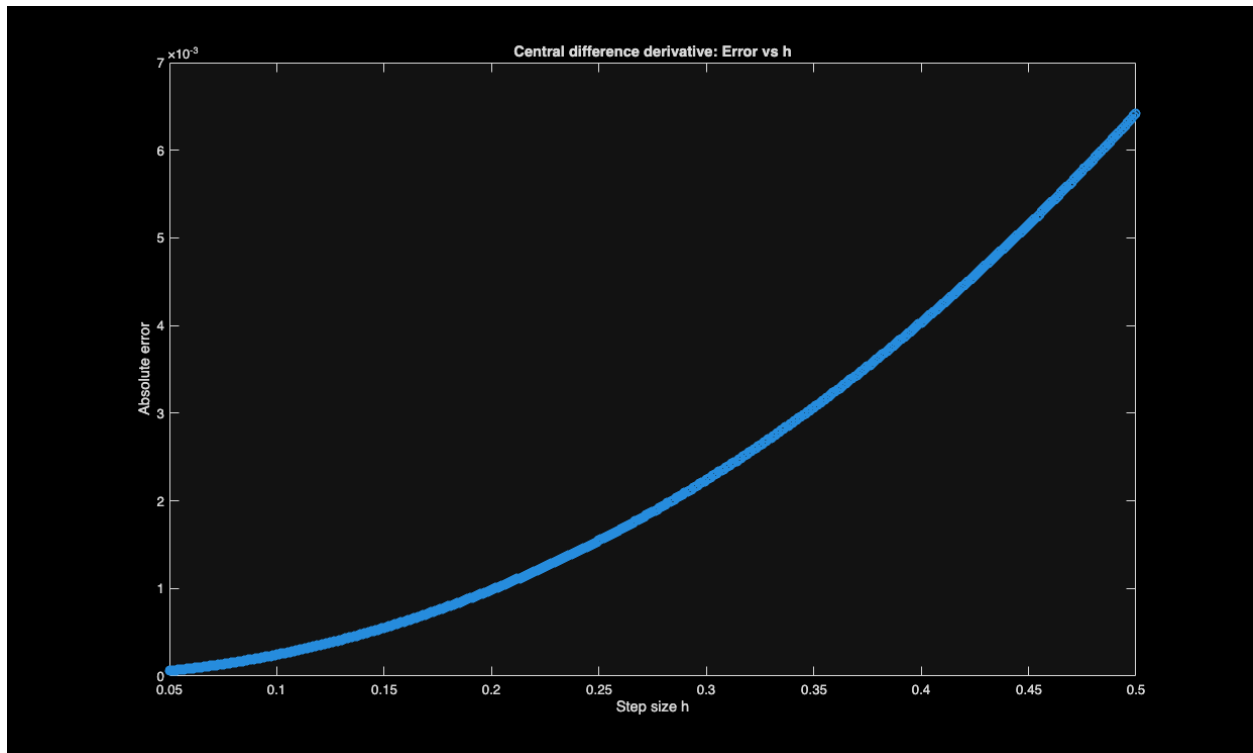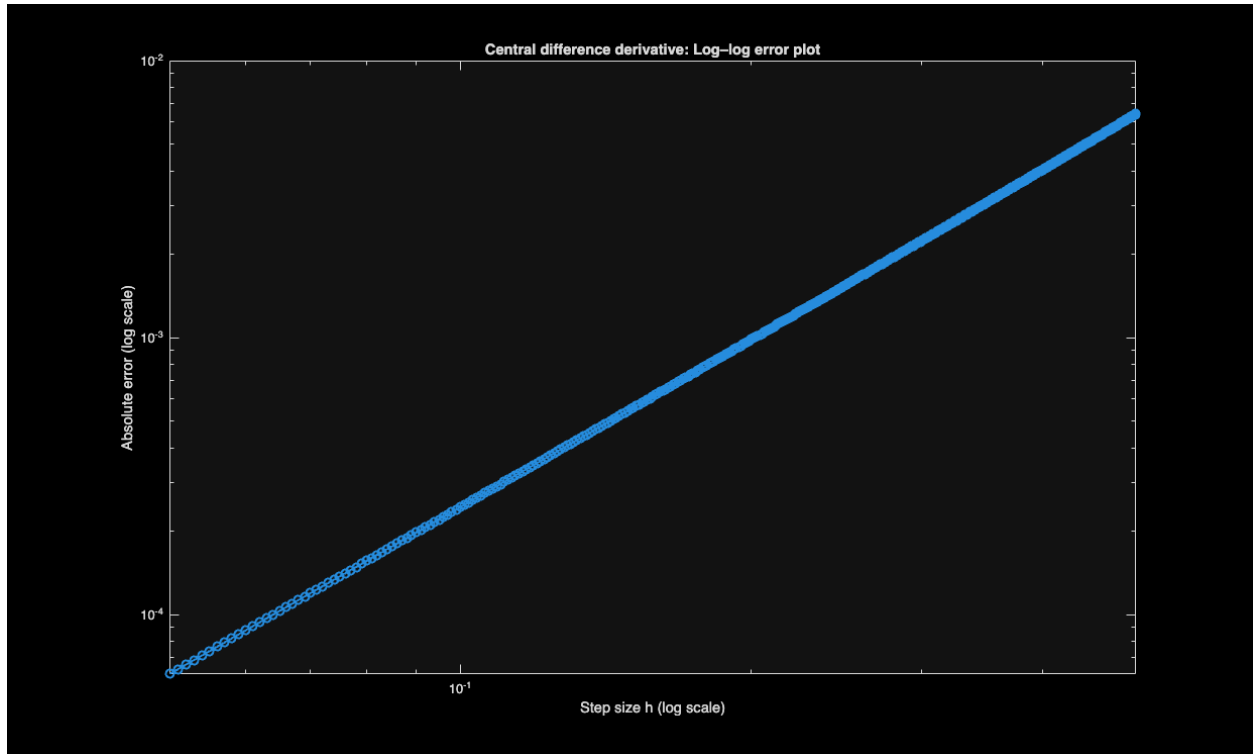
NOT PRINTING ALL!!

```
       h      Derivative      Abs_Error
---------------------------------------------
   0.486     -1.04267808  6.04679885e-03
```

```
0.471      −1.04229433    5.66305447e−03
0.456      −1.04192466    5.29338372e−03
0.441      −1.04156886    4.93758384e−03
0.426      −1.04122674    4.59545983e−03
0.411      −1.04089810    4.26682438e−03
0.396      −1.04058278    3.95149771e−03
0.381      −1.04028059    3.64930749e−03
0.366      −1.03999137    3.36008869e−03
0.351      −1.03971496    3.08368351e−03
0.336      −1.03945122    2.81994126e−03
0.321      −1.03920000    2.56871824e−03
0.306      −1.03896116    2.32987770e−03
0.291      −1.03873457    2.10328971e−03
0.276      −1.03852011    1.88883108e−03
0.261      −1.03831766    1.68638530e−03
0.246      −1.03812712    1.49584245e−03
0.231      −1.03794838    1.31709913e−03
0.216      −1.03778134    1.15005840e−03
0.201      −1.03762591    9.94629721e−04
0.186      −1.03748201    8.50728870e−04
0.171      −1.03734956    7.18277920e−04
0.156      −1.03722848    5.97205169e−04
0.141      −1.03711872    4.87445104e−04
0.126      −1.03702022    3.88938349e−04
0.111      −1.03693291    3.01631638e−04
0.096      −1.03685676    2.25477770e−04
0.081      −1.03679171    1.60435588e−04
0.066      −1.03673775    1.06469945e−04
0.051      −1.03669483    6.35516862e−05
```

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