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MAT 331

Project 1

14 February 2020

%The implementation of functions f and g, runs a loop to calculate the

%desired values.

function Question1()

%prints the functions f and g for the

%x value in the loop

xVals = [];

fVals = [];

gVals = [];

%populate the function vectors at each x value

for i=1:20

xVals(i) = 5 ^ -i;

fVals(i) = f(xVals(i));

gVals(i) = g(xVals(i));

end

%create the table with the transposes of each row vector

t = table(xVals',fVals',gVals','VariableNames',["x","f", "g"])

function val = f(x)

val = sqrt(x^2 + 4) - 2;

function val = g(x)

val = (x ^ 2) / (sqrt(x^2 + 4) + 2);

>> Question1()

t =

20×3 table

x f g

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0.2 0.0099751 0.0099751

0.04 0.00039996 0.00039996

0.008 1.6e-05 1.6e-05

0.0016 6.4e-07 6.4e-07

0.00032 2.56e-08 2.56e-08

6.4e-05 1.024e-09 1.024e-09

1.28e-05 4.096e-11 4.096e-11

2.56e-06 1.6382e-12 1.6384e-12

5.12e-07 6.5281e-14 6.5536e-14

1.024e-07 2.6645e-15 2.6214e-15

2.048e-08 0 1.0486e-16

4.096e-09 0 4.1943e-18

8.192e-10 0 1.6777e-19

1.6384e-10 0 6.7109e-21

3.2768e-11 0 2.6844e-22

6.5536e-12 0 1.0737e-23

1.3107e-12 0 4.295e-25

2.6214e-13 0 1.718e-26

5.2429e-14 0 6.8719e-28

1.0486e-14 0 2.7488e-29

Function g is more accurate since there is a loss of significance error in function f after 5^-10, where function g gives the function value even though its close to 0.

%implements functions f, g and h

function Question2(a, b, n)

%create the step size for 101 points

stepSize = (b - a) / (n-1);

xVals = a : stepSize : b;

%initialize the function vectors

fVals = [];

gVals = [];

hVals = [];

%evaluate the functions on xVals

for i=1:length(xVals)

x = xVals(i);

fVals(i) = f(x);

gVals(i) = g(x);

hVals(i) = h(x);

end

%plot the functions

figure(1);

plot(xVals,fVals,'black',xVals,gVals,'blue',xVals,hVals,'red')

xlim([a b])

legend('f','g','h')

%create a table

t = table(xVals',fVals',gVals',hVals','VariableNames',["x","f","g","h"])

function val = f(x)

%creating a coefficient vector

coeffs = [1 -10 45 -120 210 -252 210 -120 45 -10 1];

val = 0;

%looping back direction to preserve order

for i=11:-1:1

val = val + (x ^ (i-1)) \* coeffs(i);

end

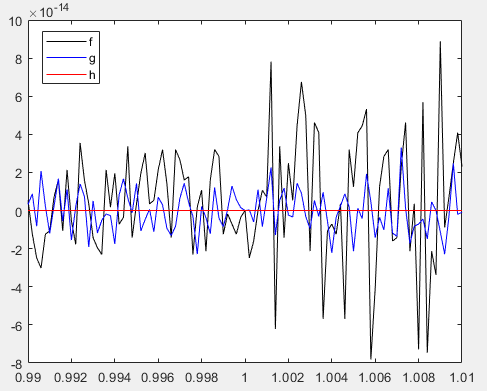
function val = g(x)

val = 1 + x \* (-10 + x \* (45 + x \* (-120 + x \* (210 + x \* (-252 + x \* (210 + x \* (-120 + x \* (45 + x \* (-10 + x)))))))));

function val = h(x)

val = (x-1)^10;

Interval 1 (0.99, 1.01) :



>> Question2(0.99,1.01,101)

t =

101×4 table

x f g h

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0.99 5.32907051820075e-15 3.21964677141295e-15 1.00000000000001e-20

0.9902 -1.24344978758018e-14 8.77076189453874e-15 8.17072806887573e-21

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0.9912 7.105427357601e-15 2.33146835171283e-15 2.78500976009412e-21

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1.0084 -7.46069872548105e-14 -1.48769885299771e-14 1.74901228765973e-21

1.0086 -2.1316282072803e-14 4.55191440096314e-15 2.21301578888016e-21

1.0088 -3.37507799486048e-14 0 2.78500976009376e-21

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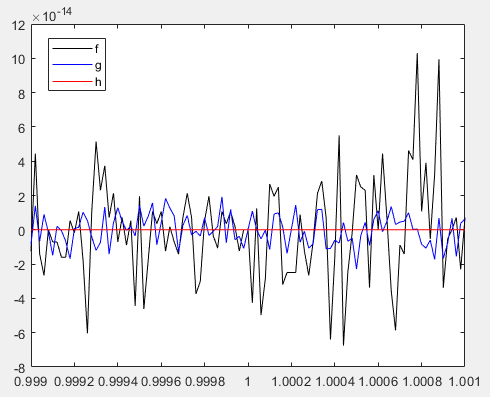
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1.0098 4.08562073062058e-14 -1.99840144432528e-15 8.17072806887573e-21

1.01 2.30926389122033e-14 -8.88178419700125e-16 1.00000000000001e-20

Interval 2 (0.999,1.001) :



>> Question2(0.999,1.001,101)

t =

101×4 table

x f g h

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0.99912 -7.105427357601e-15 2.1094237467878e-15 2.78500976009377e-31

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0.99916 -1.59872115546023e-14 -6.66133814775094e-15 1.74901228766112e-31

0.99918 5.32907051820075e-15 -1.68753899743024e-14 1.37448031336033e-31

0.9992 -1.77635683940025e-15 6.66133814775094e-16 1.07374182400031e-31

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1.00034 2.8421709430404e-14 1.18793863634892e-14 2.0643777540602e-35

1.00036 7.105427357601e-15 -1.11022302462516e-14 3.65615844005444e-35

1.00038 -6.3948846218409e-14 -1.08801856413265e-14 6.2782118479593e-35

1.0004 -1.59872115546023e-14 -5.99520433297585e-15 1.04857599999885e-34

1.00042 5.50670620214078e-14 -7.7715611723761e-15 1.70801981216229e-34

1.00044 -6.75015598972095e-14 4.21884749357559e-15 2.71973609384157e-34

1.00046 -2.48689957516035e-14 -6.66133814775094e-15 4.24207474826889e-34

1.00048 -1.77635683940025e-15 -4.88498130835069e-15 6.49250621082933e-34

1.0005 3.19744231092045e-14 -2.28705943072782e-14 9.76562499998924e-34

1.00052 2.48689957516035e-14 -3.10862446895044e-15 1.44555105948651e-33

1.00054 2.30926389122033e-14 4.32986979603811e-15 2.10832519264862e-33

1.00056 -3.37507799486048e-14 -9.10382880192628e-15 3.0330548909554e-33

1.00058 3.19744231092045e-14 6.10622663543836e-15 4.30804206897942e-33

1.0006 0 1.0991207943789e-14 6.04661759999334e-33

1.00062 4.44089209850063e-14 -1.11022302462516e-15 8.39299365866214e-33

1.00064 7.105427357601e-15 4.88498130835069e-15 1.15292150460638e-32

1.00066 -3.5527136788005e-14 1.35447209004269e-14 1.56833688090801e-32

1.00068 -5.86197757002083e-14 3.10862446895044e-15 2.11392282015764e-32

1.0007 -8.88178419700125e-15 4.55191440096314e-15 2.82475248999689e-32

1.00072 -1.4210854715202e-14 4.9960036108132e-15 3.74390624261575e-32

1.00074 4.61852778244065e-14 9.99200722162641e-15 4.92399039735341e-32

1.00076 4.08562073062058e-14 2.22044604925031e-16 6.4288889323291e-32

1.00078 1.03028696685215e-13 4.44089209850063e-16 8.33577583123651e-32

1.0008 1.06581410364015e-14 -8.43769498715119e-15 1.07374182399882e-31

1.00082 3.90798504668055e-14 -1.06581410364015e-14 1.3744803133566e-31

1.00084 -5.32907051820075e-15 -5.99520433297585e-15 1.74901228765881e-31

1.00086 3.19744231092045e-14 -1.73194791841524e-14 2.21301578887673e-31

1.00088 9.9475983006414e-14 6.88338275267597e-15 2.78500976009377e-31

1.0009 -3.37507799486048e-14 -1.66533453693773e-14 3.48678440099616e-31

1.00092 -5.32907051820075e-15 -7.7715611723761e-15 4.34388454222734e-31

1.00094 0 6.66133814775094e-15 5.38615114094561e-31

1.00096 7.105427357601e-15 -1.55431223447522e-14 6.64832635990461e-31

1.00098 -2.30926389122033e-14 3.77475828372553e-15 8.17072806887388e-31

1.001 7.105427357601e-15 6.43929354282591e-15 9.99999999998899e-31

Functions f and g give different values since they are calculated in different orders, and g is calculated in nested form which reduces the number of multiplication operations compared to f. Function h is the most accurate since it involves a single subtraction operation raised to a power.