Programming Assignment 1

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Question Number 1.

Matlab Code

h=0.05 and h=0.025

```
clear all
clc
f=@(t,y)2+sqrt(y-2*t+3);
t0=0;
y0=1;
tn=0.5;
h=0.05;
fprintf('\nvalues for h=0.05  ');
fprintf('\n t        y ');
p = 0;
 while p<=0.5
    q=1+(4*p)+(0.25*p*p);
    plot(p,q,'y.');
    hold on;
    p=p+0.005;
end
while t0<=tn
    fprintf('\n%4.5f  %4.5f ',t0,y0);
    plot(t0,y0,'r*');
    hold on;
    k1=h*f(t0,y0);
    k2=h*f(t0+h,y0+k1);
    y1=y0+(k1+k2)/2;
    t1=t0+h;
    t0=t1;
    y0=y1;
end

t0=0;
y0=1;
tn=0.5;
h=0.025;
fprintf('\nvalues for h=0.025  ');
 fprintf('\n t        y ');
while t0<=tn
    fprintf('\n%4.5f  %4.5f ',t0,y0);
    plot(t0,y0,'bo');
    hold on;
    k1=h*f(t0,y0);
    k2=h*f(t0+h,y0+k1);
    y1=y0+(k1+k2)/2;
    t1=t0+h;
    t0=t1;
    y0=y1;
end

fprintf('\n%4.5f  %4.5f \n',t0,y0);
plot(t0,y0,'bo');
hold on;
title('(red *)=Plot of with h=0.05, (blue o)=Plot of with h=0.025, (yellow ...)=Plot of actual solution')
xlabel('t-->')
ylabel('y(t)-->')
```

Tables

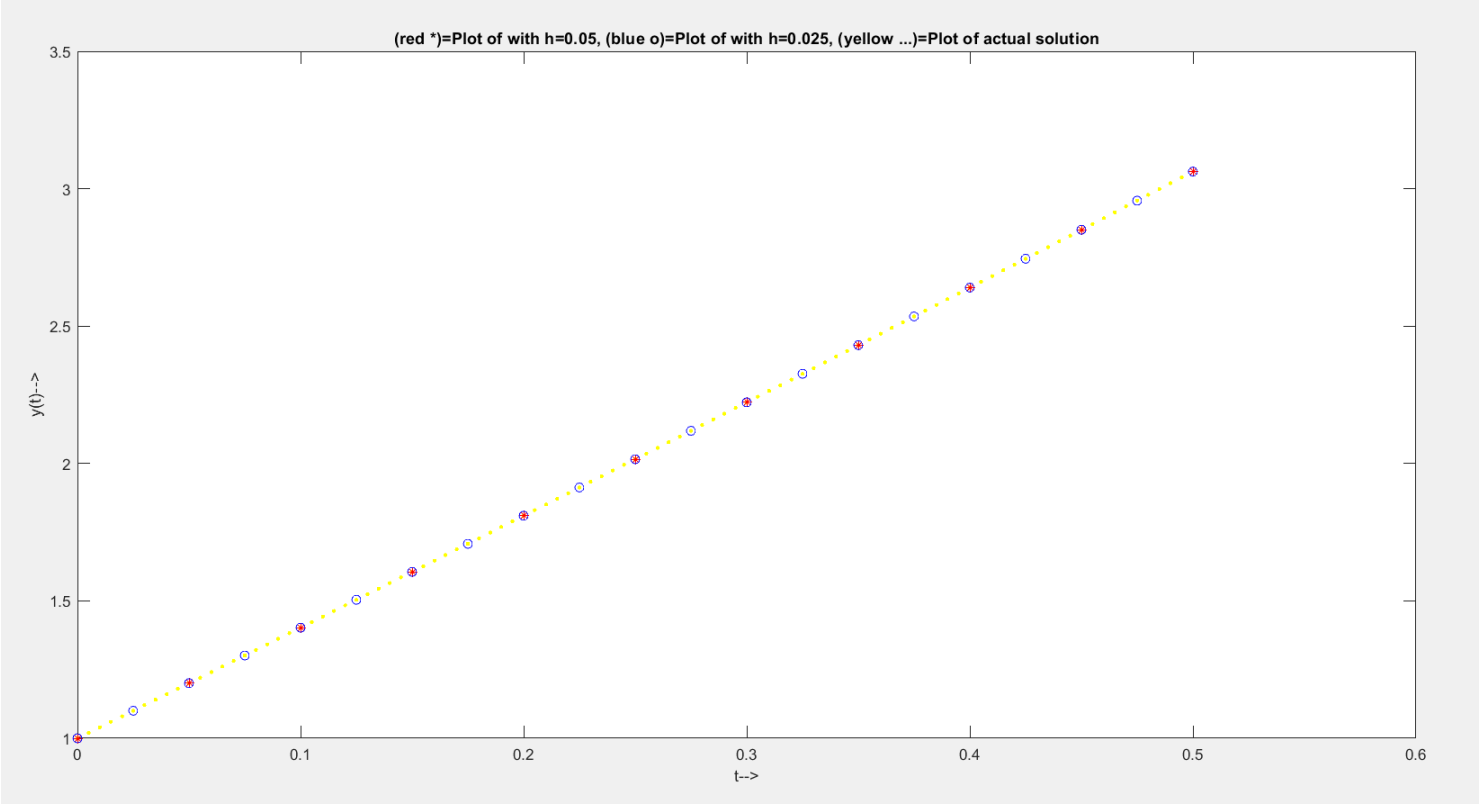
h=0.05

t	y(t)(Numerical Solution)	y(t)(Exact Solution)
0.00000	1.00000	1.00000
0.05000	1.20062	1.20063
0.10000	1.40249	1.40250
0.15000	1.60561	1.60563
0.20000	1.80998	1.81000
0.25000	2.01561	2.01563
0.30000	2.22248	2.22250
0.35000	2.43060	2.43063
0.40000	2.63997	2.64000
0.45000	2.85059	2.85062
0.50000	3.06246	3.06250

h=0.025

t	y(t)(Numerical Solution)	y(t)(Exact Solution)
0.00000	1.00000	1.00000
0.02500	1.10016	1.10016
0.05000	1.20062	1.20063
0.07500	1.30140	1.30141
0.10000	1.40250	1.40250
0.12500	1.50390	1.50391
0.15000	1.60562	1.60563
0.17500	1.70765	1.70766
0.20000	1.81000	1.81000
0.22500	1.91265	1.91266
0.25000	2.01562	2.01563
0.27500	2.11890	2.11891
0.30000	2.22249	2.22250
0.32500	2.32640	2.32641
0.35000	2.43062	2.43063
0.37500	2.53515	2.53516
0.40000	2.63999	2.64000
0.42500	2.74515	2.74516
0.45000	2.85062	2.85063
0.47500	2.95640	2.95641
0.50000	3.06249	3.06250

Graph


(red *)=Plot of with h=0.05, (blue o)=Plot of with h=0.025, (yellow ...)=Plot of actual solution
3.5
3
2.5
2
1.5
1
y(t)-->
0
0.1
0.2
0.3
0.4
0.5
0.6
t-->

Question Number 2.

Matlab Code

h=0.05 and h=0.1

```
clear all
clc
f=@(t,y)2*t*y;
h=0.05;
t = 1:h:2;
n = length(t);
Y = zeros(1,n);
Ex = zeros(1,n);
Y(1)=1;
fprintf('\nvalues for h=0.05  ');
fprintf('\nt,y');
for i = 1:n-1
   fprintf('\n%4.5f,%4.5f',t(i),Y(i));
   k1=h*f(t(i),Y(i));
   k2=h*f(t(i)+h/2.0,Y(i)+k1/2.0);
   k3=h*f(t(i)+h/2.0,Y(i)+k2/2.0);
   %t1=t0+h;
   k4=h*f(t(i+1),Y(i)+k3);
   Y(i+1)=Y(i)+(k1+2*(k2+k3)+k4)/6;
   %t0=t1;
   %y()=y1;
end
fprintf('\n%4.5f,%4.5f\n',t(n),Y(n));
plot(t,Y,'r*');
hold on;

C=@(a)(exp(a^2-1)) ;
fprintf('\nExact Solution of Y');
fprintf('\nt,y');
for i=1:n
   Ex(i) = C(t(i));
   fprintf('\n%4.5f,%4.5f',t(i),Ex(i));
end

h=0.1;
t = 1:h:2;
n = length(t);
Y = zeros(1,n);
Ex = zeros(1,n);
Y(1)=1;
fprintf('\nvalues for h=0.01  ');
fprintf('\n t        y ');
for i = 1:n-1
   fprintf('\n%4.5f,%4.5f',t(i),Y(i));
   k1=h*f(t(i),Y(i));
   k2=h*f(t(i)+h/2.0,Y(i)+k1/2.0);
   k3=h*f(t(i)+h/2.0,Y(i)+k2/2.0);
   k4=h*f(t(i+1),Y(i)+k3);
   Y(i+1)=Y(i)+(k1+2*(k2+k3)+k4)/6;
end
fprintf('\n%4.5f,%4.5f\n',t(n),Y(n));
plot(t,Y,'go');
hold on;

fprintf('\nExact Solution of Y');
fprintf('\nt,y');
for i=1:n
   Ex(i) = C(t(i));
   fprintf('\n%4.5f,%4.5f',t(i),Ex(i));
```

```
end
fplot(@(x) (exp(x^2-1)),[1 2]);
hold on;
legend({'Plot of Classical RK method with h=0.05','Plot of Classical RK method with h=0.1','Plot of actual solution'});
title('Question 2');
%title('(red *)=Plot of Classical RK method with h=0.05, (blue o)=Plot of Classical RK method with h=0.1, (yellow ...)=Plot of actual solution')
xlabel('t-->')
ylabel('y(t)-->')
```

Table

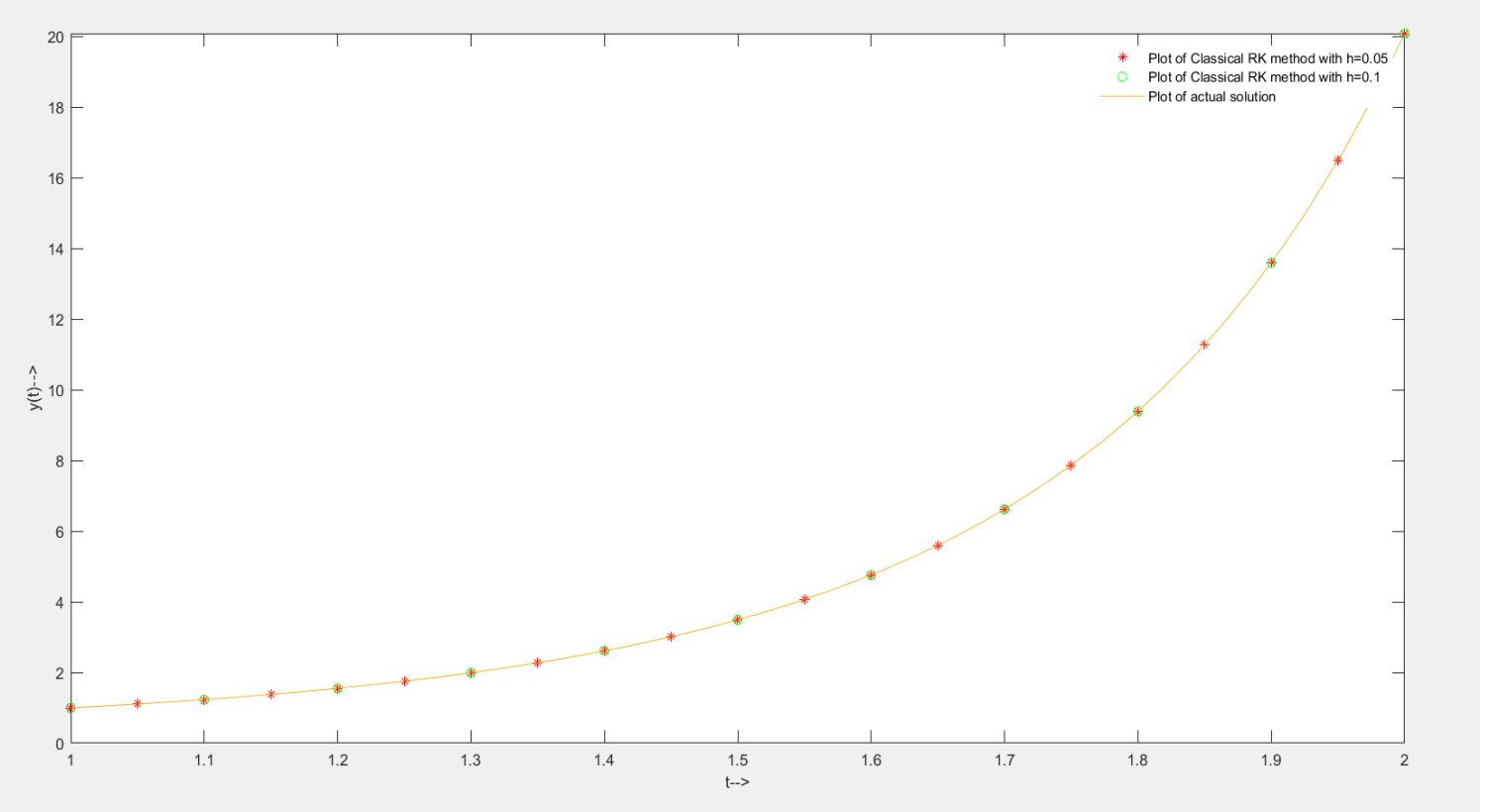
h=0.05

t	y(t) (Numerical Solution)	y(t) (Exact Solution)
1.00000	1.00000	1.00000
1.05000	1.10794	1.10794
1.10000	1.23368	1.23368
1.15000	1.38057	1.38057
1.20000	1.55271	1.55271
1.25000	1.75505	1.75505
1.30000	1.99371	1.99372
1.35000	2.27618	2.27618
1.40000	2.61169	2.61170
1.45000	3.01168	3.01169
1.50000	3.49033	3.49034
1.55000	4.06534	4.06535
1.60000	4.75880	4.75882
1.65000	5.59848	5.59851
1.70000	6.61933	6.61937
1.75000	7.86556	7.86561
1.80000	9.39326	9.39333
1.85000	11.27390	11.27401
1.90000	13.59890	13.59905
1.95000	16.48559	16.48581
2.00000	20.08523	20.08554

h=0.1

t	y(t) (Numerical Solution)	y(t) (Exact Solution)
1.00000	1.00000	1.00000
1.10000	1.23367	1.23368
1.20000	1.55270	1.55271
1.30000	1.99369	1.99372
1.40000	2.61163	2.61170
1.50000	3.49021	3.49034
1.60000	4.75855	4.75882
1.70000	6.61883	6.61937
1.80000	9.39225	9.39333
1.90000	13.59691	13.59905
2.00000	20.08127	20.08554

Graph


Plot of Classical RK method with h=0.05
Plot of Classical RK method with h=0.1
Plot of actual solution
y(t)-->
t-->
0
2
4
6
8
10
12
14
16
18
20
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2

Question Number 3.

Matlab Code

h=0.025

```
clear all
clc
h = 0.025;
t = 1:h:1.5;
n = length(t);
Y = zeros(1,n);
Ex = zeros(1,n);
E = zeros(1,n);
Y(1) = 2;
f = @(x,y) (((y.^2)+x.*y-(x.^2))./(x^2));
fprintf('\nvalues for h=0.1  ');
fprintf('\nt,y');
fprintf('\n%4.5f,%4.5f',1,Y(1));
for i = 1:n-1
    k = [0,0];
    s =fsolve(@(x)[x(1) - f(t(i)+(3-sqrt(3))*h/6,Y(i)+h*x(1)/4+(3-2*sqrt(3))*h*x(2)/12);x(2) -
f(t(i)+(3+sqrt(3))*h/6,Y(i)+h*x(2)/4+(3+2*sqrt(3))*h*x(1)/12)],k);
    Y(i+1) = Y(i)+h*(s(1)+s(2))/2;
    fprintf('\n%4.5f,%4.5f',t(i+1),Y(i+1));
end
plot(t,Y,'gx');
hold on;
fprintf('\nExact Solution  ');
fprintf('\nt,y');
for i =1:n
    x = 1+(i-1)*h;
    Ex(i) = (x*(1+(x^2)/3)/(1-(x^2)/3));
    fprintf('\n%4.5f,%4.5f',x,Ex(i));
end
plot(t,Ex,'bo');
hold on;
fprintf('\nError  ');
fprintf('\nt,error');
for i =1:n
    %x = 1+(i-1)*h;
    %E(i) = (x*(1+(x^2)/3)/(1-(x^2)/3))-Y(i);
    E(i) = Ex(i) - Y(i);
    fprintf('\n%4.5f,%4.5f',x,E(i));
end
%fplot(@(x) (x.*(1+(x.^2)/3)./(1-(x.^2)./3)),[1 1.5]);
%hold on;
plot(t,E,'r.');
hold on;
title('Question 3, h=0.025')
legend({'Numerical Solution','Exact solution'});
```

h=0.05

```
clear all
clc
h = 0.05;
t = 1:h:1.5;
n = length(t);
Y = zeros(1,n);
Ex = zeros(1,n);
E = zeros(1,n);
Y(1) = 2;
f = @(x,y) (((y.^2)+x.*y-(x.^2))./(x^2));
fprintf('\nvalues for h=0.1  ');
fprintf('\nt,y');
fprintf('\n%4.5f,%4.5f',1,Y(1));
for i = 1:n-1
    k = [0,0];
    s =fsolve(@(x)[x(1) - f(t(i)+(3-sqrt(3))*h/6,Y(i)+h*x(1)/4+(3-2*sqrt(3))*h*x(2)/12);x(2) -
f(t(i)+(3+sqrt(3))*h/6,Y(i)+h*x(2)/4+(3+2*sqrt(3))*h*x(1)/12)],k);
    Y(i+1) = Y(i)+h*(s(1)+s(2))/2;
    fprintf('\n%4.5f,%4.5f',t(i+1),Y(i+1));
end
plot(t,Y,'gx');
hold on;
fprintf('\nExact Solution  ');
fprintf('\nt,y');
for i =1:n
    x = 1+(i-1)*h;
    Ex(i) = (x*(1+(x^2)/3)/(1-(x^2)/3));
    fprintf('\n%4.5f,%4.5f',x,Ex(i));
end
plot(t,Ex,'bo');
hold on;
fprintf('\nError  ');
fprintf('\nt,error');
for i =1:n
    %x = 1+(i-1)*h;
    %E(i) = (x*(1+(x^2)/3)/(1-(x^2)/3))-Y(i);
    E(i) = Ex(i) - Y(i);
    fprintf('\n%4.5f,%4.5f',x,E(i));
end
%fplot(@(x) (x.*(1+(x.^2)/3)./(1-(x.^2)./3)),[1 1.5]);
%hold on;
plot(t,E,'r.');
hold on;
title('Question 3, h=0.05')
legend({'Numerical Solution','Exact solution'});
```

Tables

h=0.025

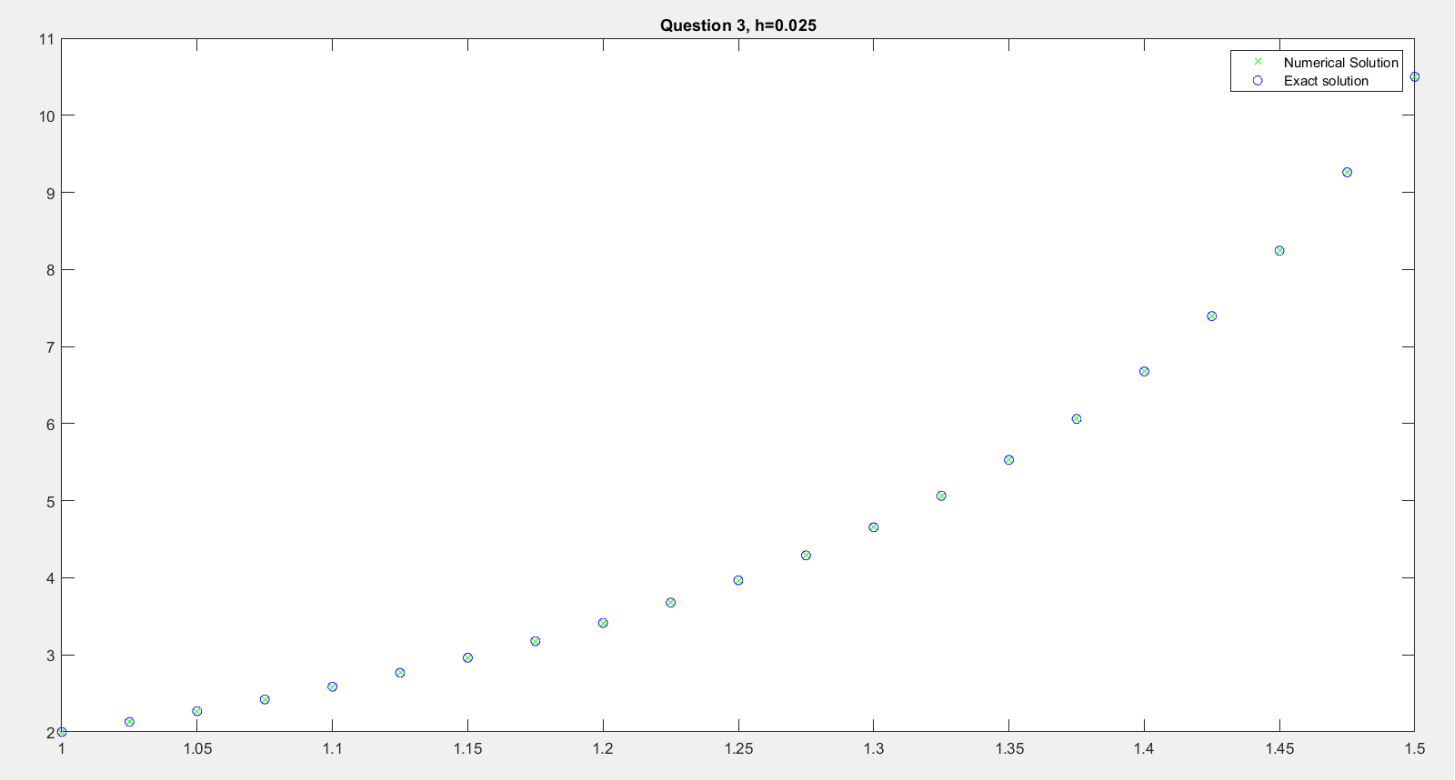
t	y(t) (Numerical Solution)	y(t) (Exact Solution)
1.00000	2.00000	2.00000
1.02500	2.12986	2.12986
1.05000	2.27016	2.27016
1.07500	2.42212	2.42212
1.10000	2.58715	2.58715
1.12500	2.76689	2.76689
1.15000	2.96326	2.96326
1.17500	3.17853	3.17853
1.20000	3.41538	3.41538
1.22500	3.67704	3.67704
1.25000	3.96739	3.96739
1.27500	4.29117	4.29117
1.30000	4.65420	4.65420
1.32500	5.06375	5.06375
1.35000	5.52898	5.52898
1.37500	6.06162	6.06162
1.40000	6.67692	6.67692
1.42500	7.39511	7.39512
1.45000	8.24359	8.24359
1.47500	9.26040	9.26041
1.50000	10.49998	10.50000

h=0.05

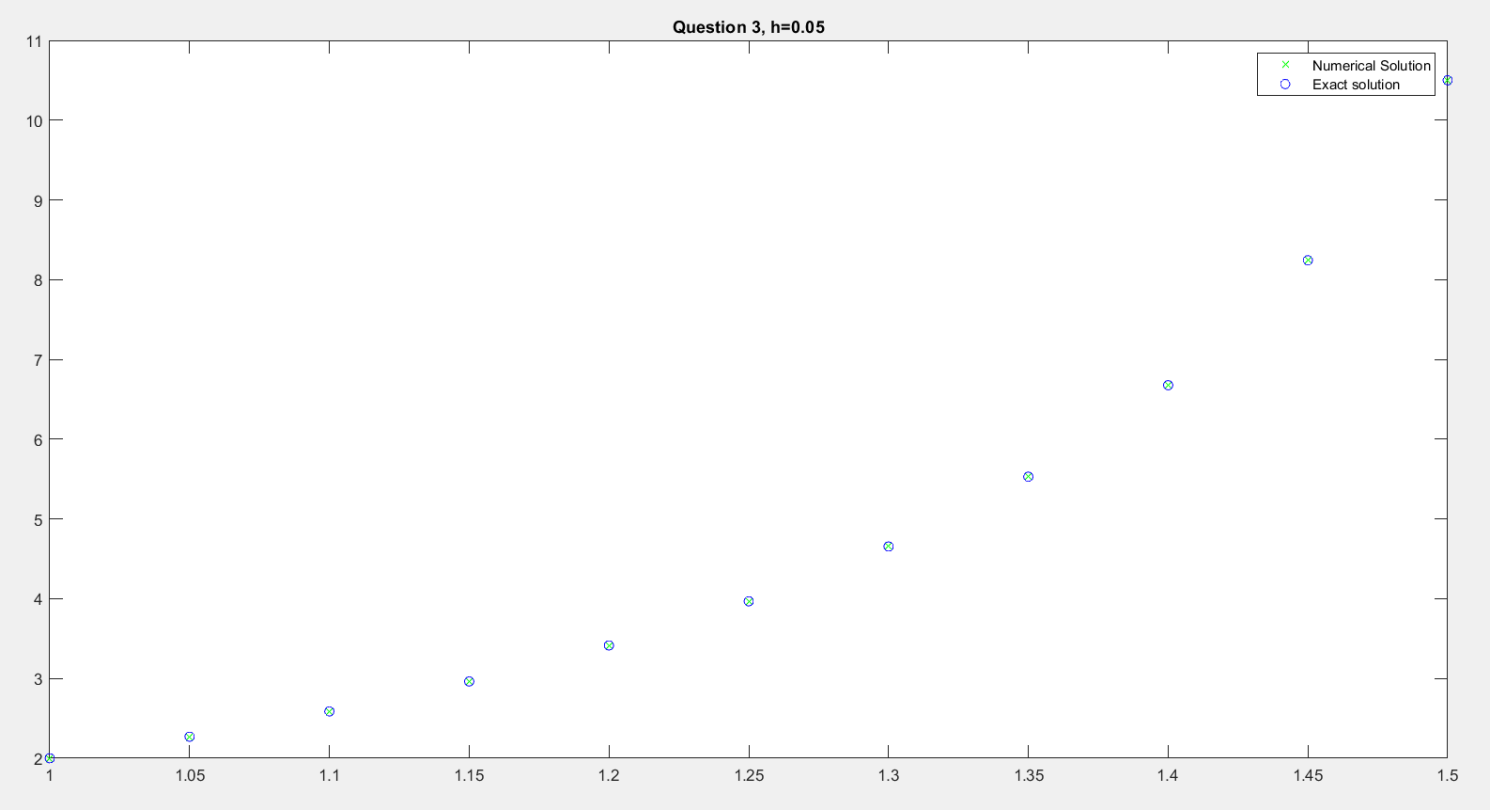
t	y(t) (Numerical Solution)	y(t) (Exact Solution)
1.00000	2.00000	2.00000
1.05000	2.27016	2.27016
1.10000	2.58715	2.58715
1.15000	2.96326	2.96326
1.20000	3.41538	3.41538
1.25000	3.96739	3.96739
1.30000	4.65420	4.65420
1.35000	5.52898	5.52898
1.40000	6.67692	6.67692
1.45000	8.24359	8.24359
1.50000	10.49998	10.50000

Graphs

h=0.025



h=0.05



Question Number 4.

Matlab Code

h=0.05

```
clear all
clc
h=0.05;
t=0:h:1;
n=length(t);
X=zeros(1,n);
Y=zeros(1,n);
X(1)=1;
Y(1)=2;
f=@(x,y) ((-3)*x+4*y);
g=@(x,y) ((-2)*x+3*y);

for i=1:n-1
    k1=h*f(X(i),Y(i));
    l1=h*g(X(i),Y(i));

    k2=h*f(X(i)+k1/2,Y(i)+l1/2);
    l2=h*g(X(i)+k1/2,Y(i)+l1/2);

    k3=h*f(X(i)+k2/2,Y(i)+l2/2);
    l3=h*g(X(i)+k2/2,Y(i)+l2/2);

    k4=h*f(X(i)+k3,Y(i)+l3);
    l4=h*g(X(i)+k3,Y(i)+l3);

    k=(1/6)*(k1+2*k2+2*k3+k4);
    X(i+1)=X(i)+k;
    l=(1/6)*(l1+2*l2+2*l3+l4);
    Y(i+1)=Y(i)+l;

end
fprintf('Numerical Solution of X\n');
fprintf('t       X\n');
for i=1:n
    fprintf('%4.5f,%4.5f\n',t(i),X(i));
end
fprintf('\nNumerical Solution of Y\n');
fprintf('t       Y\n');
for i=1:n
    fprintf('%4.5f,%4.5f\n',t(i),Y(i));
end
J=zeros(1,n);
M=zeros(1,n);
b=@(a) (3*exp(a)-2*exp(-a));
c=@(a) (3*exp(a)-exp(-a));
fprintf('\nExact Solution of X\n');
fprintf('t       X\n');
for i=1:n
    J(i)=b(t(i));
    fprintf('%4.5f,%4.5f\n',t(i),J(i));
end
fprintf('\nExact Solution of Y\n');
fprintf('t       Y\n');
for i=1:n
    M(i)=c(t(i));
```

```
    fprintf('%4.5f,%4.5f\n',t(i),M(i));
end
plot(t,X,'r.');
hold on;
plot(t,J,'bo-');
hold on;
plot(t,Y,'gx');
hold on;
plot(t,Y,'k+-');
hold on;
%pt,J,t,Y,t,M);
legend({'Numerical solution of x','Exact solution of x','Numerical solution of y','Exact solution of y'});
title('Question 4 - Using h = 0.05');
grid on;
grid minor;
xlabel('t-->')
ylabel('x(t) or y(t)-->')
```

h=0.1

```
clear all
clc
h=0.1;
t=0:h:1;
n=length(t);
X=zeros(1,n);
Y=zeros(1,n);
X(1)=1;
Y(1)=2;
f=@(x,y) ((-3)*x+4*y);
g=@(x,y) ((-2)*x+3*y);

for i=1:n-1
    k1=h*f(X(i),Y(i));
    l1=h*g(X(i),Y(i));

    k2=h*f(X(i)+k1/2,Y(i)+l1/2);
    l2=h*g(X(i)+k1/2,Y(i)+l1/2);

    k3=h*f(X(i)+k2/2,Y(i)+l2/2);
    l3=h*g(X(i)+k2/2,Y(i)+l2/2);

    k4=h*f(X(i)+k3,Y(i)+l3);
    l4=h*g(X(i)+k3,Y(i)+l3);

    k=(1/6)*(k1+2*k2+2*k3+k4);
    X(i+1)=X(i)+k;
    l=(1/6)*(l1+2*l2+2*l3+l4);
    Y(i+1)=Y(i)+l;

end
fprintf('Numerical Solution of X\n');
fprintf('t       X\n');
for i=1:n
    fprintf('%4.5f,%4.5f\n',t(i),X(i));
```

```
end
fprintf('\nNumerical Solution of Y\n');
fprintf('t       Y\n');
for i=1:n
    fprintf('%4.5f,%4.5f\n',t(i),Y(i));
end
J=zeros(1,n);
M=zeros(1,n);
b=@(a) (3*exp(a)-2*exp(-a));
c=@(a) (3*exp(a)-exp(-a));
fprintf('\nExact Solution of X\n');
fprintf('t       X\n');
for i=1:n
    J(i)=b(t(i));
    fprintf('%4.5f,%4.5f\n',t(i),J(i));
end
fprintf('\nExact Solution of Y\n');
fprintf('t       Y\n');
for i=1:n
    M(i)=c(t(i));
    fprintf('%4.5f,%4.5f\n',t(i),M(i));
end
plot(t,X,'r.');
hold on;
plot(t,J,'bo-');
hold on;
plot(t,Y,'gx');
hold on;
plot(t,Y,'k+-');
hold on;
%pt,J,t,Y,t,M);
legend({'Numerical solution of x','Exact solution of x','Numerical solution of y','Exact solution of y'});
title('Question 4 - Using h = 0.05');
grid on;
grid minor;
xlabel('t-->')
ylabel('x(t) or y(t)-->')
```

Tables

h=0.05

Numerical Solution of x(t)

t	x(t) (Numerical Solution)	x(t) (Exact Solution)
0.00000	1.00000	1.00000
0.05000	1.25135	1.25135
0.10000	1.50584	1.50584
0.15000	1.76409	1.76409
0.20000	2.02675	2.02675
0.25000	2.29447	2.29447
0.30000	2.56794	2.56794
0.35000	2.84783	2.84783
0.40000	3.13483	3.13483
0.45000	3.42968	3.42968
0.50000	3.73310	3.73310
0.55000	4.04586	4.04586
0.60000	4.36873	4.36873
0.65000	4.70253	4.70253
0.70000	5.04809	5.04809
0.75000	5.40627	5.40627
0.80000	5.77796	5.77796
0.85000	6.16411	6.16411
0.90000	6.56567	6.56567
0.95000	6.98365	6.98365
1.00000	7.41909	7.41909

Numerical Solution of y(t)

t	y(t) (Numerical Solution)	y(t) (Exact Solution)
0.00000	2.00000	2.00000
0.05000	2.20258	2.20258
0.10000	2.41068	2.41068
0.15000	2.62479	2.62479
0.20000	2.84548	2.84548
0.25000	3.07328	3.07328
0.30000	3.30876	3.30876
0.35000	3.55251	3.55251
0.40000	3.80515	3.80515
0.45000	4.06731	4.06731
0.50000	4.33963	4.33963
0.55000	4.62281	4.62281
0.60000	4.91754	4.91754
0.65000	5.22458	5.22458
0.70000	5.54467	5.54467
0.75000	5.87863	5.87863
0.80000	6.22729	6.22729
0.85000	6.59153	6.59153
0.90000	6.97224	6.97224
0.95000	7.37039	7.37039
1.00000	7.78697	7.78697

h=0.1

Numerical Solution of x(t)

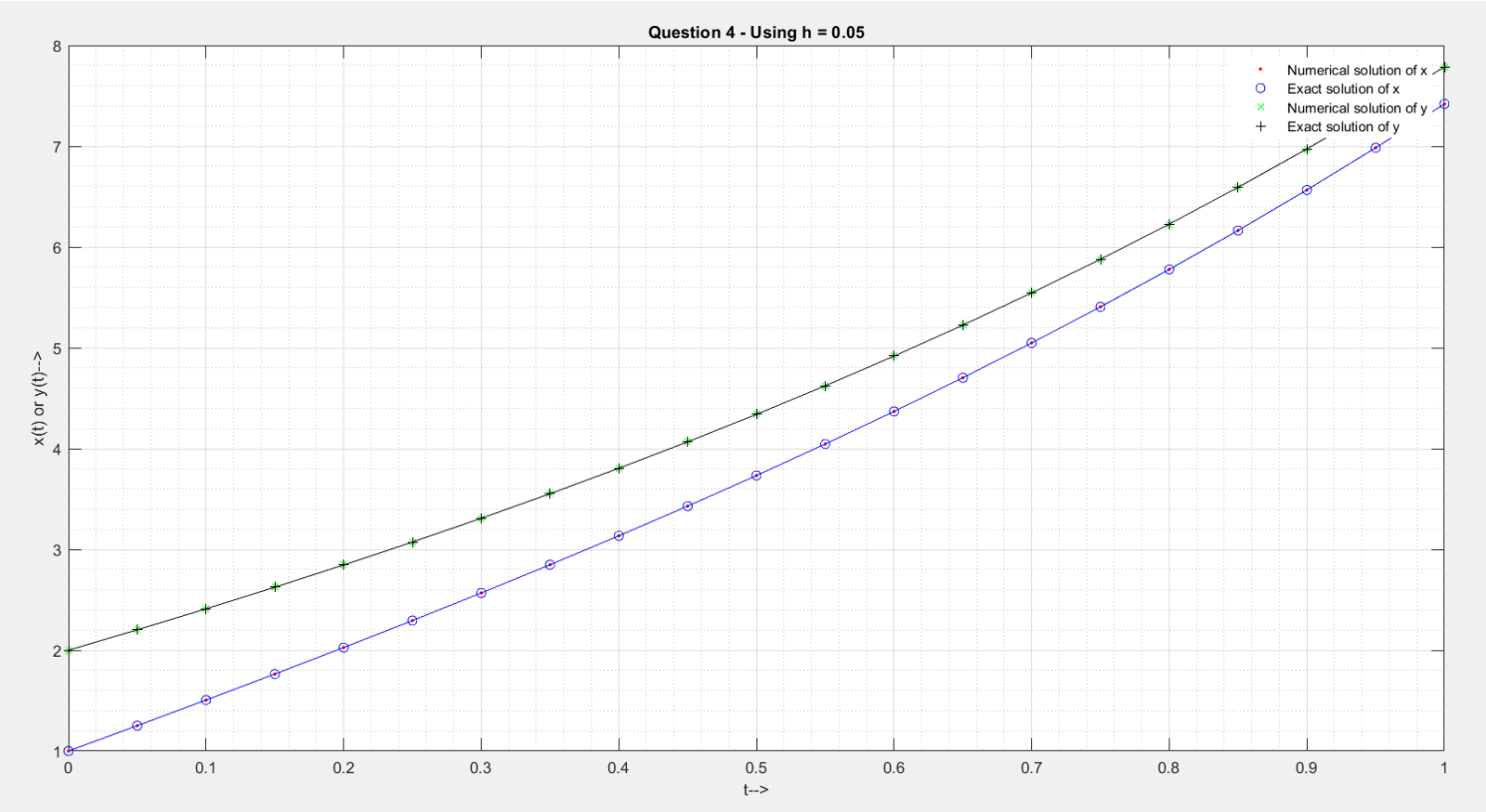
t	x(t) (Numerical solution)	x(t) (Exact Solution)
0.00000	1.00000	1.00000
0.10000	1.50584	1.50584
0.20000	2.02675	2.02675
0.30000	2.56794	2.56794
0.40000	3.13483	3.13483
0.50000	3.73310	3.73310
0.60000	4.36873	4.36873
0.70000	5.04808	5.04809
0.80000	5.77796	5.77796
0.90000	6.56566	6.56567
1.00000	7.41908	7.41909

Numerical Solution of y(t)

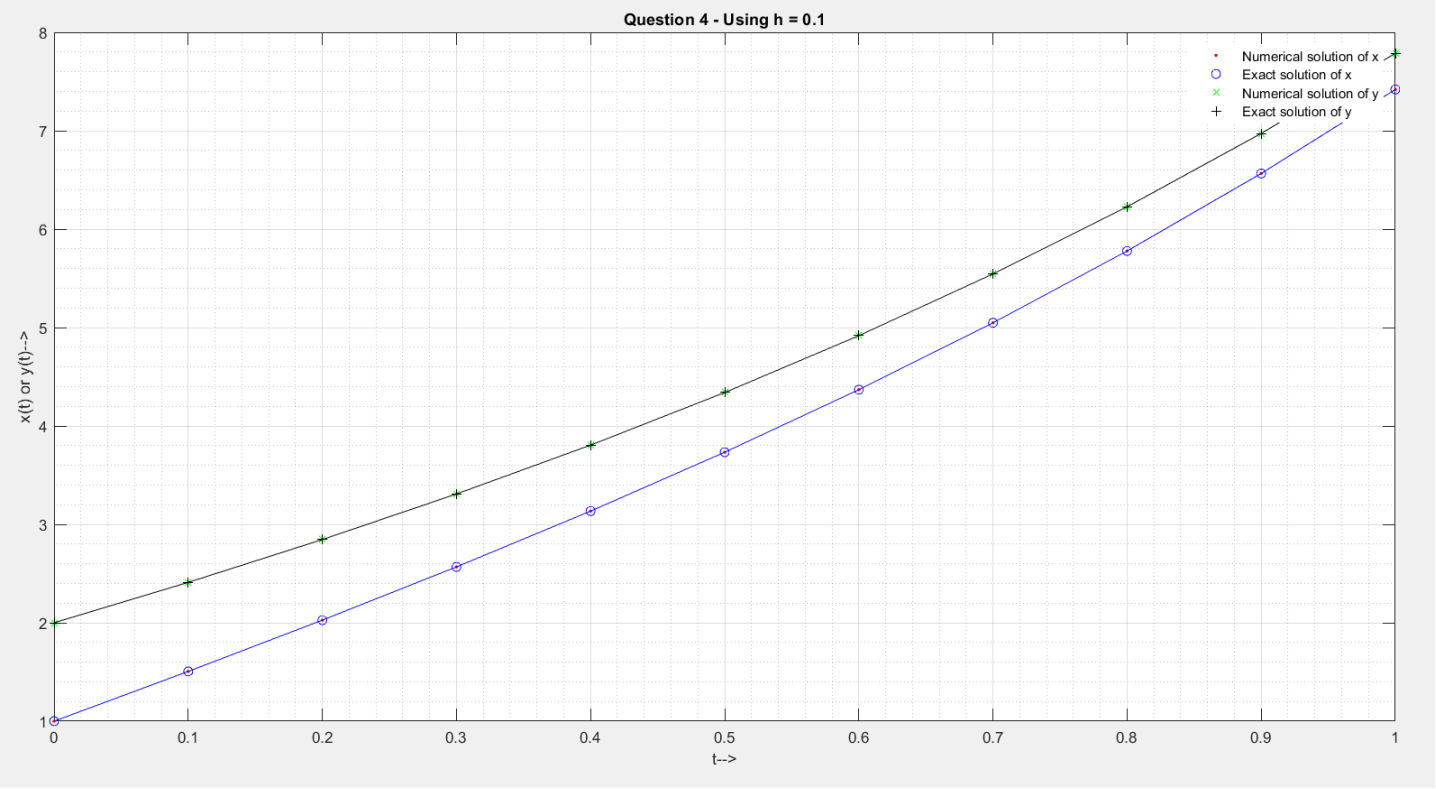
t	y(t) (Numerical Solution)	y(t) (Exact Solution)
0.00000	2.00000	2.00000
0.10000	2.41067	2.41068
0.20000	2.84548	2.84548
0.30000	3.30876	3.30876
0.40000	3.80515	3.80515
0.50000	4.33963	4.33963
0.60000	4.91754	4.91754
0.70000	5.54467	5.54467
0.80000	6.22729	6.22729
0.90000	6.97223	6.97224
1.00000	7.78696	7.78697

Graphs

h=0.05



h=0.1



Question Number 5.

Matlab Code

h=0.05

```
clear all
clc
f = @(x, u) (-2 * u * u);
g = @(u1, u0, h) (h*u1*u1 + u1 + h*u0*u0 - u0);
g1 = @(u, h) (2*h*u + 1);

h = 0.05;
x=0:h:1;
n=length(x);
u=zeros(1,n);
y=zeros(1,n);
u(1) = 1;
y(1) = f(x(1), u(1));

for i = 1 : 4
  Up = u(i);
  while 1
    u(i+1) = Up - g(Up, u(i), h) / g1(Up, h);
    if (abs(u(i+1) - Up) <= 0.00001)
      break;
    end
    Up = u(i+1);
  end
  y(i+1) = f(x(i+1), u(i+1));
end


for i = 4 : n-1
  u(i+1) = u(i-3) + 4*h*(2*y(i) - y(i-1) + 2*y(i-2))/3;
  y(i+1) = f(x(i+1), u(i+1));
  u(i+1) = u(i-1) + h*(y(i+1) + 4*y(i) + y(i-1))/3;
end

fprintf('Numerical Solution of u\n');
fprintf('t       u\n');
for i=1:n
    fprintf('%4.5f\t%4.5f\n',x(i),u(i));
end
plot(x,u,'ro-');
legend({'Numerical solution of u'});
title('Question 5, h=0.05');
grid on;
grid minor;
xlabel('x-->')
ylabel('u(x)-->')
```

h=0.1

```
clear all
clc
f = @(x, u) (-2 * u * u);
g = @(u1, u0, h) (h*u1*u1 + u1 + h*u0*u0 - u0);
g1 = @(u, h) (2*h*u + 1);

h = 0.1;
x=0:h:1;
n=length(x);
u=zeros(1,n);
y=zeros(1,n);
u(1) = 1;
y(1) = f(x(1), u(1));

for i = 1 : 4
  Up = u(i);
  while 1
    u(i+1) = Up - g(Up, u(i), h) / g1(Up, h);
    if (abs(u(i+1) - Up) <= 0.00001)
      break;
    end
    Up = u(i+1);
  end
  y(i+1) = f(x(i+1), u(i+1));
end


for i = 4 : n-1
  u(i+1) = u(i-3) + 4*h*(2*y(i) - y(i-1) + 2*y(i-2))/3;
  y(i+1) = f(x(i+1), u(i+1));
  u(i+1) = u(i-1) + h*(y(i+1) + 4*y(i) + y(i-1))/3;
end

fprintf('Numerical Solution of u\n');
fprintf('t        u\n');
for i=1:n
    fprintf('%4.5f\t%4.5f\n',x(i),u(i));
end
plot(x,u,'ro-');
legend({'Numerical solution of u'});
title('Question 5, h=0.1');
grid on;
grid minor;
xlabel('x-->')
ylabel('u(x)-->')
```

Tables

h=0.05

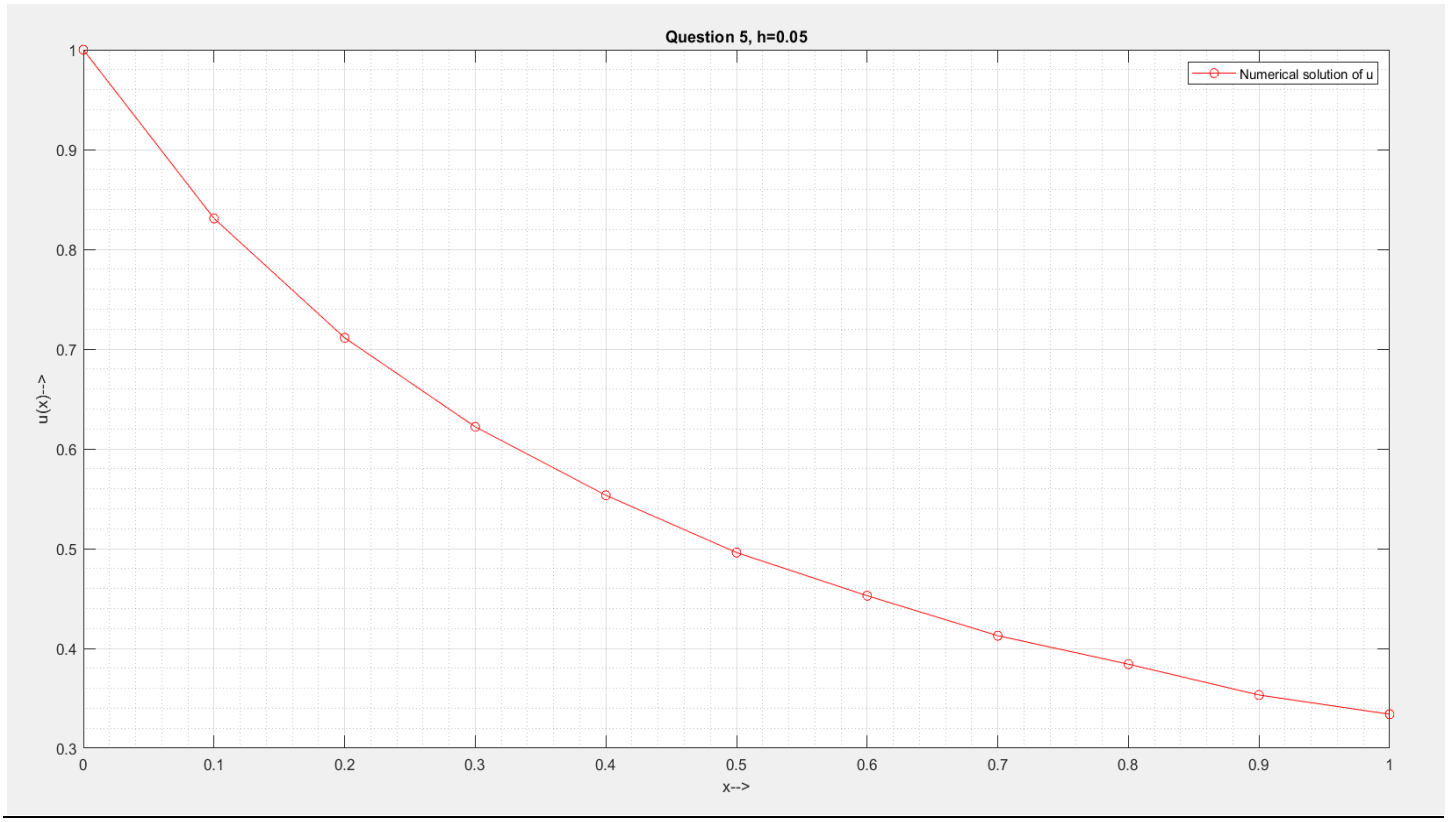
x	u(x) (Numerical Solution)
0.00000	1.00000
0.05000	0.90871
0.10000	0.83275
0.15000	0.76854
0.20000	0.71385
0.25000	0.66594
0.30000	0.62461
0.35000	0.58756
0.40000	0.55530
0.45000	0.52571
0.50000	0.49986
0.55000	0.47562
0.60000	0.45450
0.65000	0.43424
0.70000	0.41670
0.75000	0.39947
0.80000	0.38471
0.85000	0.36984
0.90000	0.35729
0.95000	0.34430
1.00000	0.33354

h=0.1

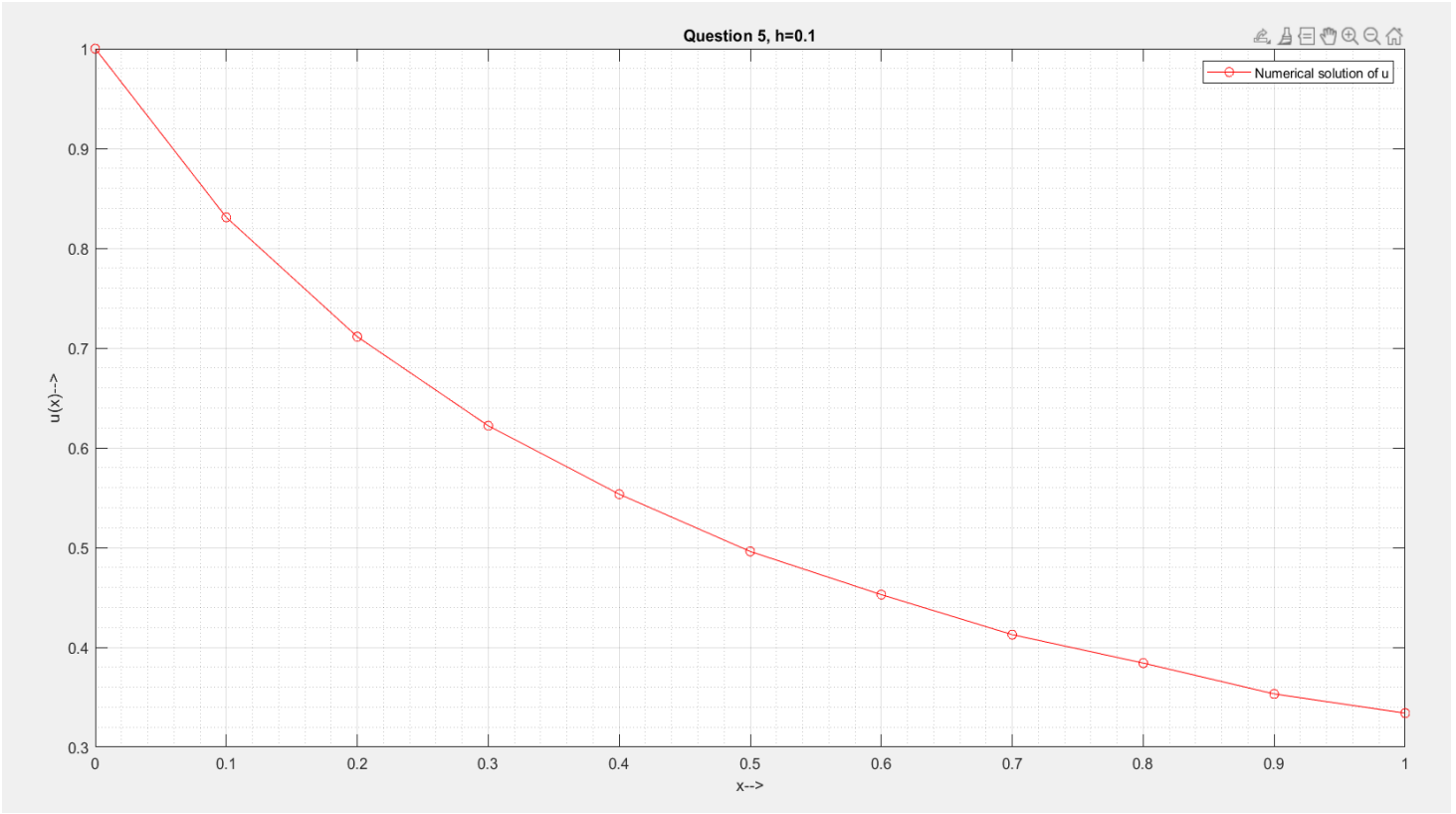
x	u(x) (Numerical Solution)
0.00000	1.00000
0.10000	0.83095
0.20000	0.71131
0.30000	0.62202
0.40000	0.55347
0.50000	0.49605
0.60000	0.45279
0.70000	0.41274
0.80000	0.38420
0.90000	0.35327
1.00000	0.33404

Graph

h=0.05



h=0.1



Question Number 6.

Matlab Code

h=0.05

```
clear all
clc
h=0.05;
x=0:h:1;
n=length(x);
f=@(x,u) (-2*u^3);
u=zeros(n);
y=zeros(n);
u(1)=1;
y(1) = f(x(1), u(1));
for i = 1 : 4
    k1=h*f(x(i),u(i));
    k2=h*f(x(i)+h/2,u(i)+k1/2);
    k3=h*f(x(i)+h/2,u(i)+k2/2);
    k4=h*f(x(i)+h,u(i)+k3);
    k=(1/6)*(k1+2*k2+2*k3+k4);
    u(i+1)=u(i)+k;
    y(i+1)=f(x(i+1),u(i+1));
end

for i = 4 : n-1
  u(i+1) = u(i-3) + 4*h*(2*y(i) - y(i-1) + 2*y(i-2))/3;
  k=u(i+1);
  y(i+1) = f(x(i+1), u(i+1));
  u(i+1) = u(i-1) + h*(y(i+1) + 4*y(i) + y(i-1))/3;
  y(i+1) = f(x(i+1), u(i+1));
  while abs(u(i+1)-k) > 0.0001
      k=u(i+1);
      u(i+1) = u(i-1) + h*(y(i+1) + 4*y(i) + y(i-1))/3;
      y(i+1) = f(x(i+1), u(i+1));
  end
end
fprintf('Numerical Solution of u\n');
fprintf('t       u\n');
for i=1:n
    fprintf('%4.5f\t%4.5f\n',x(i),u(i));
end
plot(x,u,'.-');
title('Question 6, h=0.05');
legend({'Numerical solution of u'});
grid on;
grid minor;
xlabel('x-->')
ylabel('u(x)-->')
```

h=0.1

```
clear all
clc
h=0.1;
x=0:h:1;
n=length(x);
f=@(x,u) (-2*u^3);
u=zeros(n);
y=zeros(n);
u(1)=1;
y(1) = f(x(1), u(1));
for i = 1 : 4
    k1=h*f(x(i),u(i));
    k2=h*f(x(i)+h/2,u(i)+k1/2);
    k3=h*f(x(i)+h/2,u(i)+k2/2);
    k4=h*f(x(i)+h,u(i)+k3);
    k=(1/6)*(k1+2*k2+2*k3+k4);
    u(i+1)=u(i)+k;
    y(i+1)=f(x(i+1),u(i+1));
end

for i = 4 : n-1
  u(i+1) = u(i-3) + 4*h*(2*y(i) - y(i-1) + 2*y(i-2))/3;
  k=u(i+1);
  y(i+1) = f(x(i+1), u(i+1));
  u(i+1) = u(i-1) + h*(y(i+1) + 4*y(i) + y(i-1))/3;
  y(i+1) = f(x(i+1), u(i+1));
  while abs(u(i+1)-k) > 0.0001
      k=u(i+1);
      u(i+1) = u(i-1) + h*(y(i+1) + 4*y(i) + y(i-1))/3;
      y(i+1) = f(x(i+1), u(i+1));
  end
end
fprintf('Numerical Solution of u\n');
fprintf('t        u\n');
for i=1:n
    fprintf('%4.5f\t%4.5f\n',x(i),u(i));
end
plot(x,u,'.-');
title('Question 6 h=0.1');
legend({'Numerical solution of u'});
grid on;
grid minor;
xlabel('x-->')
ylabel('u(x)-->')
```

Tables

h=0.05

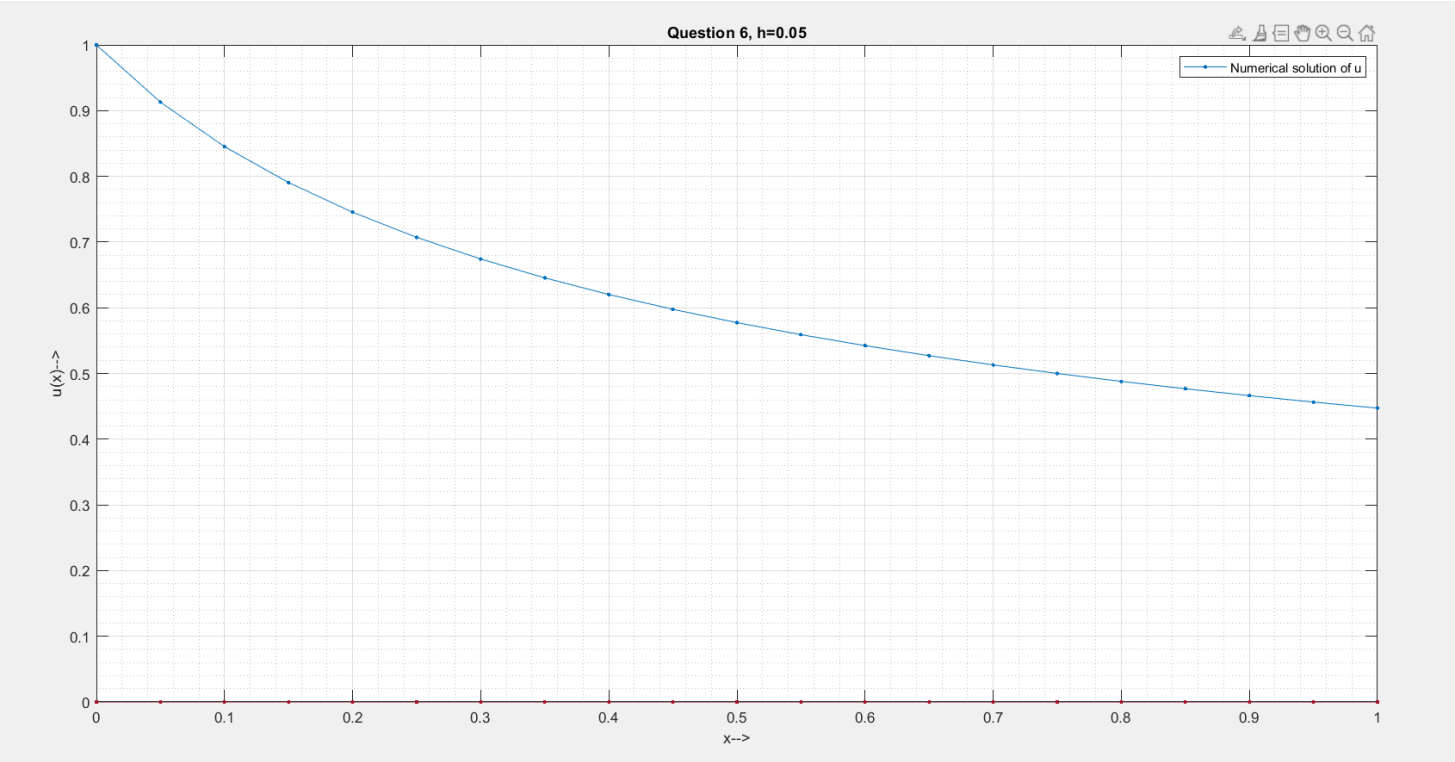
x	u(x) (Numerical Solution)
0.00000	1.00000
0.05000	0.91287
0.10000	0.84515
0.15000	0.79057
0.20000	0.74535
0.25000	0.70710
0.30000	0.67419
0.35000	0.64549
0.40000	0.62017
0.45000	0.59761
0.50000	0.57734
0.55000	0.55901
0.60000	0.54232
0.65000	0.52704
0.70000	0.51298
0.75000	0.50000
0.80000	0.48794
0.85000	0.47673
0.90000	0.46625
0.95000	0.45643
1.00000	0.44721

h=0.1

x	u(x) (Numerical Solution)
0.00000	1.00000
0.10000	0.84515
0.20000	0.74535
0.30000	0.67419
0.40000	0.62017
0.50000	0.57734
0.60000	0.54232
0.70000	0.51298
0.80000	0.48794
0.90000	0.46625
1.00000	0.44721

Graphs

h=0.05



h=0.1