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5/10/19

Project

Part I

1)

(a)

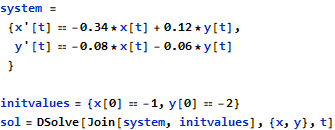






(b)

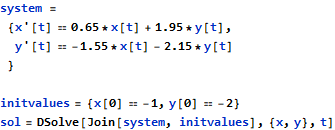






(c)





{{x -> Function[{t}, (-1. +

0. i) e^(-0.75 t) ((1. + 0. i) Cos[

1.03078 t] + (5.14176 + 3.1486\*10^-17 i) Sin[1.03078 t])],

y -> Function[{t}, -2. e^(-0.75 t) (1. Cos[

1.03078 t] - (2.11006 + 5.50981\*10^-17 i) Sin[1.03078 t])]}}

I couldn’t preserve Mathematica’s Formatting for this solution because the output is too long.

2)

For each system I made functions that also return the true solution found on Mathematica so making and editing the plots can be done easily.

(a)

function [t,x,y] = EulSystem\_1(h, t0, x0, y0, tf)

k = 1;

t(k) = t0;

x(k) = x0;

y(k) = y0;

while((t(k) + h <= tf + 10^-10))

t(k+1) = t(k) + h;

x(k+1) = x(k) + h\*(-0.5\*x(k) + 0.6\*y(k));

y(k+1) = y(k) + h\*(-0.4\*x(k) + 0.9\*y(k));

k = k + 1;

end

end

function [t,x,y] = TrueSolution\_1()

t = 0:0.1:4;

x = -exp(0.7.\*t);

y = -2.\*exp(0.7.\*t);

end

(b)

function [t,x,y] = EulSystem\_2(h, t0, x0, y0, tf)

k = 1;

t(k) = t0;

x(k) = x0;

y(k) = y0;

while((t(k) + h <= tf + 10^-10))

t(k+1) = t(k) + h;

x(k+1) = x(k) + h\*(-0.34\*x(k) + 0.12\*y(k));

y(k+1) = y(k) + h\*(-0.08\*x(k) - 0.06\*y(k));

k = k + 1;

end

end

function [t,x,y] = TrueSolution\_2()

t = 0:0.1:4;

x = -exp(-0.1.\*t);

y = -2.\*exp(-0.1.\*t);

end

(c)

function [t,x,y] = EulSystem\_3(h, t0, x0, y0, tf)

k = 1;

t(k) = t0;

x(k) = x0;

y(k) = y0;

while((t(k) + h <= tf + 10^-10))

t(k+1) = t(k) + h;

x(k+1) = x(k) + h\*(0.65\*x(k) + 1.95\*y(k));

y(k+1) = y(k) + h\*(-1.55\*x(k) - 2.15\*y(k));

k = k + 1;

end

end

function [t,x,y] = TrueSolution\_3()

t = 0:0.1:4;

x = -exp(-0.75.\*t).\*(cos(1.03078.\*t) + 5.14176.\*sin(1.03078.\*t));

y = -2.\*exp(-0.75.\*t).\*(cos(1.03078.\*t)-2.11006.\*sin(1.03078.\*t));

end

3)

function CreateSubplots(t1,x1,y1,t2,x2,y2,tvec,xvec,yvec)

ax1 = subplot(4,2,1);

ax2 = subplot(4,2,2);

ax34 = subplot(4,2,[3,4]);

ax5 = subplot(4,2,5);

ax6 = subplot(4,2,6);

ax78 = subplot(4,2,[7,8]);

plot(ax1,t1,x1,"blue",tvec,xvec,"black")

title(ax1,"x(t) vs t with h=0.25")

xlabel(ax1,"t Axis")

ylabel(ax1,"x(t) Axis")

plot(ax2,t1,y1,"blue",tvec,yvec,"black")

title(ax2,"y(t) vs t with h=0.25")

xlabel(ax2,"t Axis")

ylabel(ax2,"y(t) Axis")

plot(ax34,x1,y1,"blue",xvec,yvec,"black")

title(ax34,"y(t) vs x(t) with h=0.25")

xlabel(ax34,"x(t) Axis")

ylabel(ax34,"y(t) Axis")

plot(ax5,t2,x2,"blue",tvec,xvec,"black")

title(ax5,"x(t) vs t with h=0.1")

xlabel(ax5,"t Axis")

ylabel(ax5,"x(t) Axis")

plot(ax6,t2,y2,"blue",tvec,yvec,"black")

title(ax6,"y(t) vs t with h=0.1")

xlabel(ax6,"t Axis")

ylabel(ax6,"y(t) Axis")

plot(ax78,x2,y2,"blue",xvec,yvec,"black")

title(ax78,"y(t) vs x(t) with h=0.1")

xlabel(ax78,"x(t) Axis")

ylabel(ax78,"y(t) Axis")

end

(a)

>> [t1,x1,y1] = EulSystem\_1(0.25,0,-1,-2,4);

>> [t2,x2,y2] = EulSystem\_1(0.1,0,-1,-2,4);

>> [tvec,xvec,yvec] = TrueSolution\_1();

>> CreateSubplots(t1,x1,y1,t2,x2,y2,tvec,xvec,yvec);



Figure 1: Plots of the solutions to the first system with step sizes 0.25, and 0.1

(b)

>> [t1,x1,y1] = EulSystem\_2(0.25,0,-1,-2,4);

>> [t2,x2,y2] = EulSystem\_2(0.1,0,-1,-2,4);

>> [tvec,xvec,yvec] = TrueSolution\_2();

>> CreateSubplots(t1,x1,y1,t2,x2,y2,tvec,xvec,yvec);



Figure 2: Plots of the solutions for the second system with step sizes 0.25, and 0.1

(c)

>> [t1,x1,y1] = EulSystem\_3(0.25,0,-1,-2,4);

>> [t2,x2,y2] = EulSystem\_3(0.1,0,-1,-2,4);

>> [tvec,xvec,yvec] = TrueSolution\_3();

>> CreateSubplots(t1,x1,y1,t2,x2,y2,tvec,xvec,yvec);



Figure 3: Plots of the solutions for the third system with step sizes 0.25, and 0.1

4)

(a)

Using a step size of 0.25 deviated further from the true solution as x approaches 4 as expected, but as x gets arbitrarily close to 4 the estimated solution