Assignment #1

ME135-02L-Spring2018

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Problem 1.

1. In one of the engineering applications the relation of x and y is given by:

$$\frac{dy}{dx} = 4e^{0.8x} - 0.5y \quad , \qquad y(0) = 2$$

Solve the equation above for $0 \leq x \leq 2$ using:

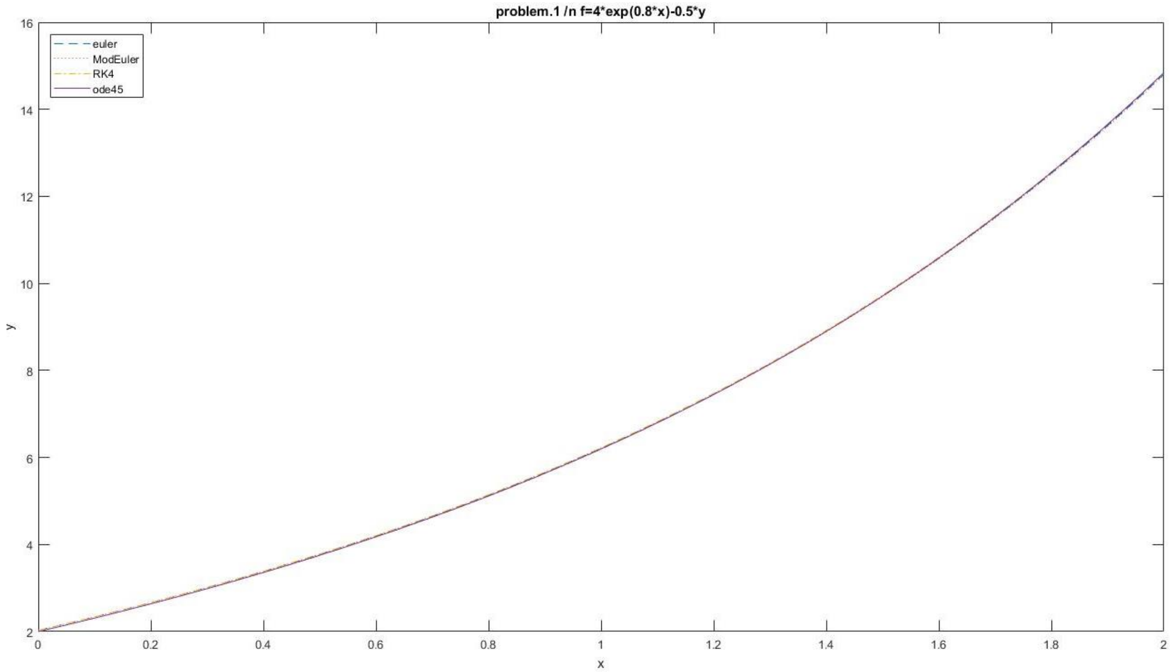
- Euler's Method.
- Modified Euler's Method.
- 4^{th} order Runge-Kutta Method.

Use MATLAB code for the solution and plot the solutions on the same graph for comparison, use a step size of 0.01.

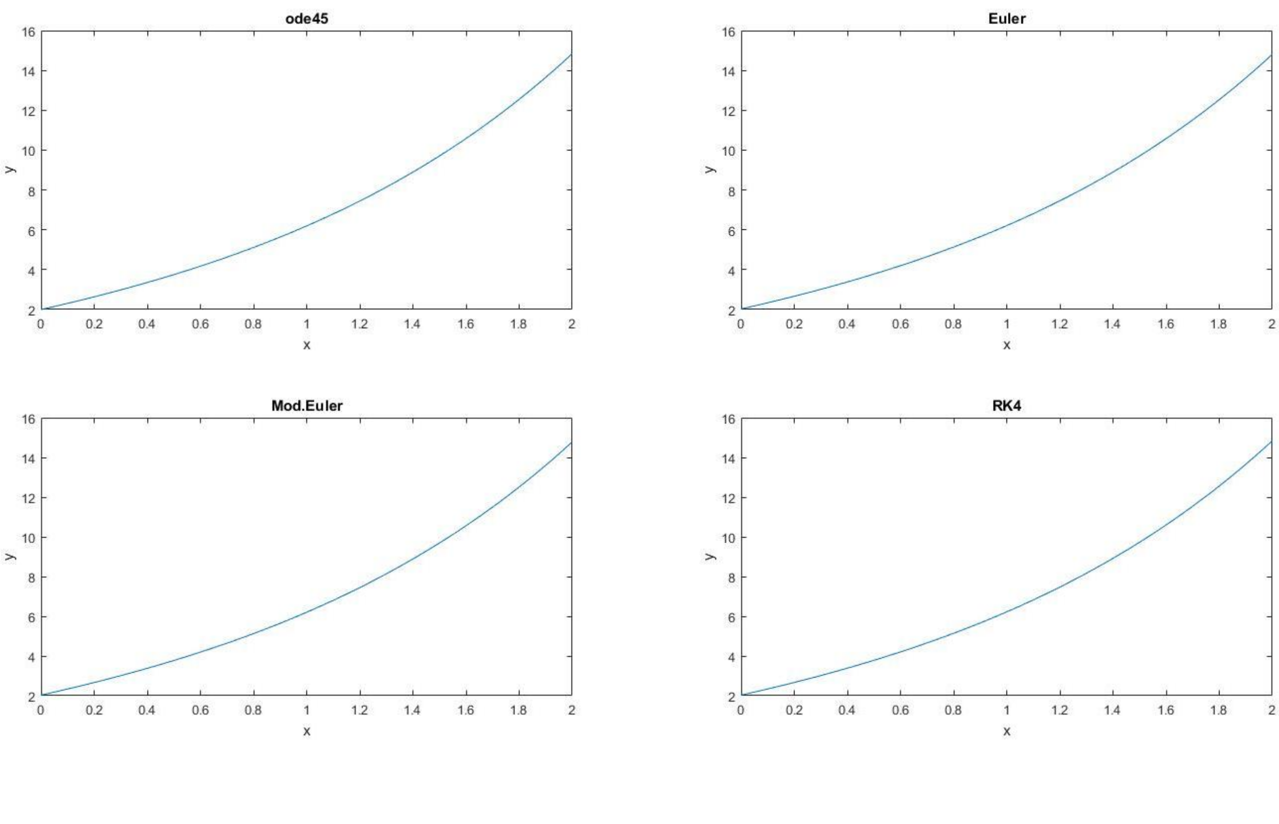
To solve this problem Euler's, Modified Euler's, 4^{th} order Runge-Kutta method, and ode45 were used. To get a better comparison between the methods I created two graphs one with all the methods compiled on a single graph and another with each separate. The code used for this problem is available in the appendix A and on git hub [https://github.com/Yeash96/Eng135.FEA/tree/master/Assigment_1].

Matlab input and output

>>Pr1



problem.1 /n f=4*exp(0.8*x)-0.5*y
euler
ModEuler
RK4
ode45
y
x



ode45
Euler
Mod.Euler
RK4
y
x

Problem 2.

2. A metal sphere at temperature of 1200k radiates heat to the surroundings (300k). If the ball started radiation at time $t = 0$, the temperature of the ball with time is given by:

$$\frac{d\theta}{dt} = -2.2067 \times 10^{-12}(\theta^4 - 81 \times 10^8) \quad , \quad \theta(t = 0) = 1200$$

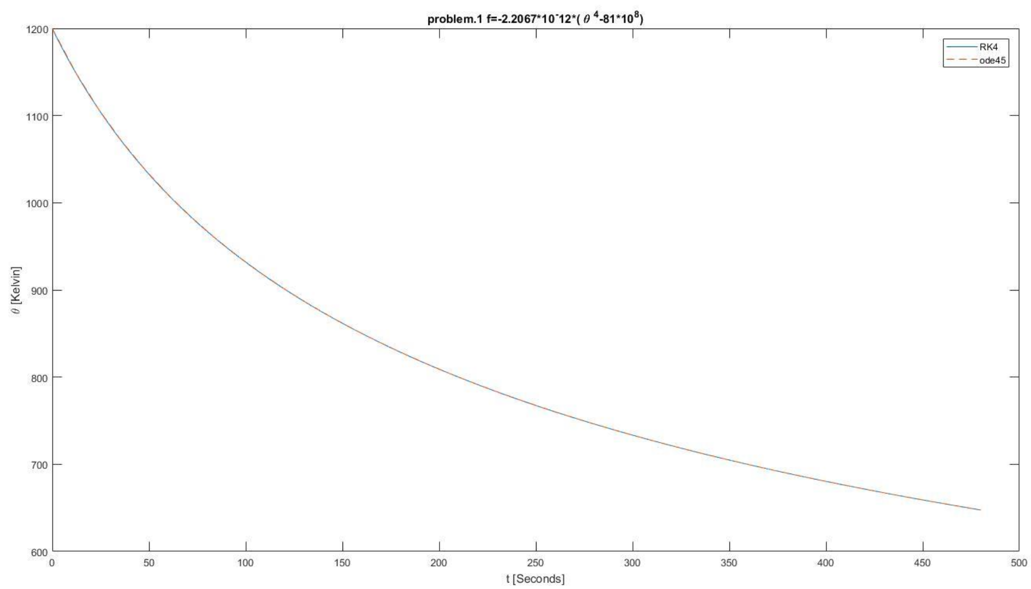
where: $\boldsymbol{\theta}$ is the temperature in Kelvin and **t** is the time in seconds.

Use 4th order Runge-Kutta method and ODE45 to find the ball temperature after 480 seconds of starting the process.
Compare between the results from the two methods.

To solve this problem 4th order Runge-Kutta (RK4) method and ode45 were used. By comparing the two we find that they the RK4 method to be very accurate. I did used 48000 iterations with a step size of 0.001 which must have greatly aided in its accuracy. The code used for this problem is available in the appendix A and on git hub [https://github.com/Yeash96/Eng135.FEA/tree/master/Assigment_1].

Matlab input and output

>>Pr2



Appendix A

Pr1.m

```
clc
clear all
close all

%given stuff
f=@(x,y)4*exp(0.8*x)-0.5*y; %function
alpha=2;%initial value
a=0;%start point
b=2;%end point
N=200;%number of iteration N= (b-a)/h h is the step size
h=0.01; %step value

x=linspace(0,2,200);%x values,
Eurz=Euler(f,a,b,alpha,N,h); %fuction returns 1x200 array using euler method
MEZ=ModEuler(f,a,b,alpha,N,h); %fuction returns 1x200 array using mod.euler
method
RK4z=RK4(f,a,b,alpha,N,h); %fuction returns 1x200 array using runga-kutta 4
method
[t,y]=ode45(f,[0,2],2); %matlabs ode function solver returns t=45x1, y=45x1
array

%graphing stuff
figure(1)
plot(x,Eurz,'--',x,MEZ,':',x,RK4z,'-.',t,y);
legend('euler','ModEuler','RK4','ode45','Location','NorthWest')
xlabel('x')
ylabel('y')
title('problem.1 /n f=4*exp(0.8*x)-0.5*y')

figure(2)
subplot(2,2,1)
plot(t,y)
title('ode45')
xlabel('x')
ylabel('y')
subplot(2,2,2)
plot(x,Eurz)
title('Euler')
xlabel('x')
ylabel('y')
subplot(2,2,3)
plot(x,MEZ)
title('Mod.Euler')
xlabel('x')
ylabel('y')
subplot(2,2,4)
plot(x,RK4z)
title('RK4')
xlabel('x')
ylabel('y')
```

Pr2.m

```
clc
clear all
close all
%given stuff
f=@(t,theta)-2.2067*10^(-12)*(theta^4-81*10^8);%function
alpha=1200; % initial value
a=0; %start point
b=480; % end point
N=48000; % number of iteration N= (b-a)/h
h=0.01; % step size

x=linspace(0,480,48000); % x values
RK4z=RK4(f,a,b,alpha,N,h); % Runga-Kutta 4 method returns 1x48000
[t,y]=ode45(f,[0,480],1200); %matlabs ode function solver returns t=41x1,
y=41x1 array

% graph stuff
plot(x,RK4z,t,y,'--');
legend('RK4','ode45')
xlabel('t [Seconds]')
ylabel('\theta [Kelvin]')
title('problem.1 f=-2.2067*10^-12*( \theta ^4-81*10^8)')
```

Euler.m

```
function [E] = Euler( f,a,b,alpha,N,h )

t=a; % start point labeled as t
w=alpha; % initial value is now w
for i=(1:N)
    w=w+h*f(t,w); %eulers method formula
    E(i)=w; %records values to return
    t=a+i*h; % next step

end

end
```

ModEuler

```
function [ E ] = ModEuler(f,a,b,alpha,N,h)
t=a; % start point labeled as t
w=alpha; % initial value is now w
for i=(1:N)
    z=w+h*f(t,w); % inital eulers method to find y*i+1
    y=w+h*((f(t,w)+f(t,z))/2);% final solution to find real yi+1
    E(i)=y;% records solutions to return
    w=y; % re assign vaules for next loop
    t=a+i*h; % step foward
end
end
```

RK4.m

```
function [ E ] = RK4(f,a,b,alpha,N,h)
t=a; % start point labeled as t
w=alpha; % initial value is now w
for i=(1:N);
    %runga kutta 4 method
    k1=h*f(t,w); % solving k(n) constants
    k2=h*f(t+h/2,w+k1/2);
    k3=h*f(t+h/2,w+k2/2);
    k4=h*f(t+h,w+k3);

    w= w+1/6*(k1+2*k2+2*k3+k4); % putting it all together
    E(i)=w; % record solution to return
    t=a+i*h; % step foward

end

end
```