Indian Institute of Information Technology Vadodara

MA202: Numerical Techniques Lab
Semester: IV
Lab 6

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Section : **2A**

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Note: I have made PDF from next page using matlab only. They are in parts. I have merged them all.

Question-1(a)

Error calculation when h = 0.1

```
A=5;
H=0.1;
%calculation of value of B
B=A+H;
%Calulation of true value
truevalue=B-B^2/2+B*log(B)-(A-A^2/2+A*log(A));
% Trapezoidal Rule
h=H;
fa=2-A+log(A);
fb=2-B+log(B);
I_Trap=h/2*(fa+fb);
err_Trap=abs(truevalue-I_Trap);
disp(['Value of error while caluclated using Trapezoidal rule
 is:',num2str(err_Trap)]);
% Simpson's one by Third rule
h=(B-A)/2;
fa=2-A+log(A);
%calculation of f(a+h)
fah=2-(A+h)+log(A+h);
%calculation of f(a+2h)
fa2h=2-(A+2*h)+log(A+2*h);
I_sim1=h/3*(fa+4*fah+fa2h);
err_sim1=abs(truevalue-I_sim1);
disp(['Value of error while caluclated using Simpson one by third rule
 is:',num2str(err_sim1)]);
% Simpson's one by eight rule
h=(B-A)/3;
fa=2-A+log(A);
%calculation of f(a+h)
fah=2-(A+h)+log(A+h);
%calculation of f(a+2h)
fa2h=2-(A+2*h)+log(A+2*h);
%calculation of f(a+3h)
fa3h=2-(A+3*h)+log(A+3*h);
I_sim2=3*h/8*(fa+3*fah+3*fa2h+fa3h);
err_sim2=abs(truevalue-I_sim2);
disp(['Value of error while caluclated using Simpson one by eight rule
 is:',num2str(err_sim2)]);
```

```
Value of error while caluclated using Trapezoidal rule is:3.2678e-06
Value of error while caluclated using Simpson one by third rule
 is:3.2035e-11
Value of error while caluclated using Simpson one by eight rule
 is:1.4238e-11
```

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Question-1(b)

Error calculation when h = 0.01

```
A=5;
H=0.01;
%calculation of value of B
B=A+H;
%Calulation of true value
truevalue=B-B^2/2+B*log(B)-(A-A^2/2+A*log(A));
% Trapezoidal Rule
h=H;
fa=2-A+log(A);
fb=2-B+log(B);
I_Trap=h/2*(fa+fb);
err_Trap=abs(truevalue-I_Trap);
disp(['Value of error while caluclated using Trapezoidal rule
 is:',num2str(err_Trap)]);
% Simpson's one by Third rule
h=(B-A)/2;
fa=2-A+log(A);
%calculation of f(a+h)
fah=2-(A+h)+log(A+h);
%calculation of f(a+2h)
fa2h=2-(A+2*h)+log(A+2*h);
I_sim1=h/3*(fa+4*fah+fa2h);
err_sim1=abs(truevalue-I_sim1);
disp(['Value of error while caluclated using Simpson one by third rule
 is:',num2str(err_sim1)]);
% Simpson's one by eight rule
h=(B-A)/3;
fa=2-A+log(A);
%calculation of f(a+h)
fah=2-(A+h)+log(A+h);
%calculation of f(a+2h)
fa2h=2-(A+2*h)+log(A+2*h);
%calculation of f(a+3h)
fa3h=2-(A+3*h)+log(A+3*h);
I_sim2=3*h/8*(fa+3*fah+3*fa2h+fa3h);
err_sim2=abs(truevalue-I_sim2);
disp(['Value of error while caluclated using Simpson one by eight rule
 is:',num2str(err_sim2)]);
```

```
Value of error while caluclated using Trapezoidal rule is:3.3267e-09
Value of error while caluclated using Simpson one by third rule
 is:1.2698e-15
Value of error while caluclated using Simpson one by eight rule
 is:1.0859e-15
```

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Question-1(b&c)

Error when n=10

```
a=5;
b=7;
n=10;
truevalue=b-b^2/2+b*log(b)-(a-a^2/2+a*log(a));
% Trapezoidal Rule
h=(b-a)/n;
%vector with values a,a+h
vec=[a:h:b];
%vector with different value of function at a,a+h,a+2h,a+3h......
funvec=2-vec+log(vec);
sumfun=zeros(1,100);
for i=1:n
sumfun(i)=h/2*(funvec(i)+funvec(i+1));
end
I_Trap=sum(sumfun);
err_Trap=abs(truevalue-I_Trap);
disp(['Value of error while caluclated using Trapezoidal rule
 for a=',num2str(a),',b=',num2str(b),' and n=',num2str(n),' is
 ',num2str(err_Trap)]);
% Simpson's one by third Rule
h=(b-a)/(2*n);
vec=[a:h:b];
%vector with different value of function at a,a+h,a+2h,a+3h......
funvec=2-vec+log(vec);
sumfun=zeros(1,200);
for i=1:2:2*n-1
sumfun(i)=h/3*(funvec(i)+4*funvec(i+1)+funvec(i+2));
end
I_sim1=sum(sumfun);
err_sim1=abs(truevalue-I_sim1);
disp(['Value of error while caluclated using Simpson one by third
 rule for a=',num2str(a),',b=',num2str(b),' and n=',num2str(n),' is
 ',num2str(err_sim1)]);
% Simpson's one by eight Rule
h=(b-a)/(3*n);
vec=[a:h:b];
%vector with different value of function at a,a+h,a+2h,a+3h......
funvec=2-vec+log(vec);
sumfun=zeros(1,300);
for i=1:3:3*n-2
sumfun(i)=(3*h)/8*(funvec(i)+3*funvec(i+1)+3*funvec(i+2)+funvec(i+3));
end
I_sim2=sum(sumfun);
err_sim2=abs(truevalue-I_sim2);
disp(['Value of error while caluclated using Simpson one by eight
 rule for a=',num2str(a),',b=',num2str(b),' and n=',num2str(n),' is
 ',num2str(err_sim2)]);
% caluclation of error using matlab Trapz Function
```

```
h=(b-a)/n;
vec=[a:h:b];
funvec=2-vec+log(vec);
Q=trapz(vec,funvec);
err_trapz=abs(truevalue-Q);
disp(['Value of error caluclated while using Trapz function
 is:',num2str(err_trapz)]);
% caluclation of error using matlab Quad Function
fun=@(x)2-x+log(x);
I_quad=quad(fun,a,b);
err_quad=abs(truevalue-I_quad);
disp(['Value of error caluclated while using quad function
 is:',num2str(err_quad)]);
```

```
Value of error while caluclated using Trapezoidal rule for a=5,b=7 and
 n=10 is 0.00019045
Value of error while caluclated using Simpson one by third rule for
 a=5,b=7 and n=10 is 5.6454e-09
Value of error while caluclated using Simpson one by eight rule for
 a=5,b=7 and n=10 is 2.5093e-09
Value of error caluclated while using Trapz function is:0.00019045
Value of error caluclated while using quad function is:7.6236e-10
```

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Question-1(b&c)

Error when n=100

```
a=5;
b=7;
n=100;
truevalue=b-b^2/2+b*log(b)-(a-a^2/2+a*log(a));
% Trapezoidal Rule
h=(b-a)/n;
%vector with values a,a+h
vec=[a:h:b];
%vector with different value of function at a,a+h,a+2h,a+3h......
funvec=2-vec+log(vec);
sumfun=zeros(1,100);
for i=1:n
sumfun(i)=h/2*(funvec(i)+funvec(i+1));
end
I_Trap=sum(sumfun);
err_Trap=abs(truevalue-I_Trap);
disp(['Value of error while caluclated using Trapezoidal rule
 for a=',num2str(a),',b=',num2str(b),' and n=',num2str(n),' is
 ',num2str(err_Trap)]);
% Simpson's one by third Rule
h=(b-a)/(2*n);
vec=[a:h:b];
%vector with different value of function at a,a+h,a+2h,a+3h......
funvec=2-vec+log(vec);
sumfun=zeros(1,200);
for i=1:2:2*n-1
sumfun(i)=h/3*(funvec(i)+4*funvec(i+1)+funvec(i+2));
end
I_sim1=sum(sumfun);
err_sim1=abs(truevalue-I_sim1);
disp(['Value of error while caluclated using Simpson one by third
 rule for a=',num2str(a),',b=',num2str(b),' and n=',num2str(n),' is
 ',num2str(err_sim1)]);
% Simpson's one by eight Rule
h=(b-a)/(3*n);
vec=[a:h:b];
%vector with different value of function at a,a+h,a+2h,a+3h......
funvec=2-vec+log(vec);
sumfun=zeros(1,300);
for i=1:3:3*n-2
sumfun(i)=(3*h)/8*(funvec(i)+3*funvec(i+1)+3*funvec(i+2)+funvec(i+3));
end
I_sim2=sum(sumfun);
err_sim2=abs(truevalue-I_sim2);
disp(['Value of error while caluclated using Simpson one by eight
 rule for a=',num2str(a),',b=',num2str(b),' and n=',num2str(n),' is
 ',num2str(err_sim2)]);
% caluclation of error using matlab Trapz Function
```

```
h=(b-a)/n;
vec=[a:h:b];
funvec=2-vec+log(vec);
Q=trapz(vec,funvec);
err_trapz=abs(truevalue-Q);
disp(['Value of error caluclated while using Trapz function
 is:',num2str(err_trapz)]);
% caluclation of error using matlab Quad Function
fun=@(x)2-x+log(x);
I_quad=quad(fun,a,b);
err_quad=abs(truevalue-I_quad);
disp(['Value of error caluclated while using quad function
 is:',num2str(err_quad)]);
```

```
Value of error while caluclated using Trapezoidal rule for a=5,b=7 and
 n=100 is 1.9048e-06
Value of error while caluclated using Simpson one by third rule for
 a=5,b=7 and n=100 is 5.6577e-13
Value of error while caluclated using Simpson one by eight rule for
 a=5,b=7 and n=100 is 2.5047e-13
Value of error caluclated while using Trapz function is:1.9048e-06
Value of error caluclated while using quad function is:7.6236e-10
```

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Question 1 - LTE

Table of Contents

Numerical integration of 2 - x + ln(x)

a = 1 and b = 2 Numerical Integration for LTE Caluclation of True Value of the integration of the function from b to a

```
a = 1;
b = 2;
truvalue = integratedf(b) - integratedf(a);
% Calculating the error using Trapezoid Rule
x = trapezoid(@f, a, b);
errTrap = abs(x - truvalue);
disp(['The error while caluclated using Trapezoidal Rule is :- ',
 num2str(errTrap)]);
% Calculating the error using Simpson's One Third Rule
x = oneThird(@f, a, b);
errOneThird = abs(x - truvalue);
 disp(['The error while caluclated using Simpson''s One Third Rule
 is :- ', num2str(errOneThird)]);
% Calculating the error using Simpson's Three Eighth Rule
x = threeEighth(@f, a, b);
errThreeEighth = abs(x - truvalue);
disp(['The error while caluclated using Simpson''s Three Eighth Rule
 is :- ', num2str(errThreeEighth)]);
```

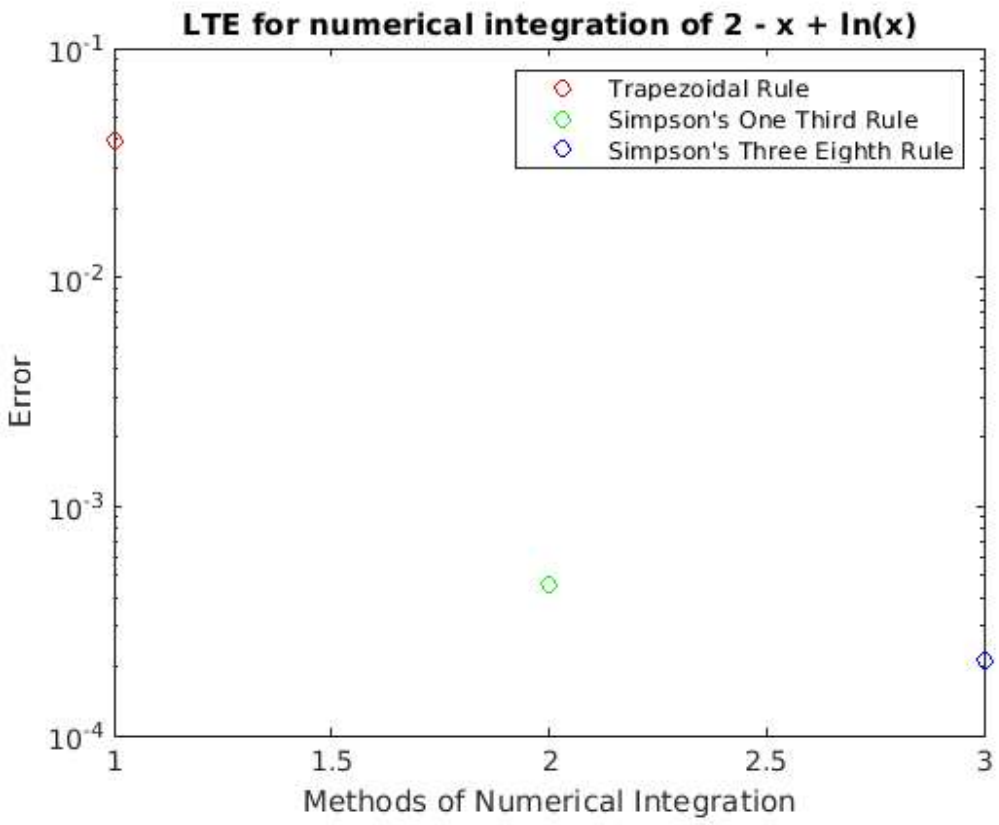
```
The error while caluclated using Trapezoidal Rule is :- 0.039721
The error while caluclated using Simpson's One Third Rule is :-
 0.00045976
The error while caluclated using Simpson's Three Eighth Rule is :-
 0.00021058
```

Plotings

```
semilogy(1, errTrap,'ro', 2, errOneThird, 'go', 3,
 errThreeEighth, 'bo')
legend('Trapezoidal Rule', 'Simpson''s One Third Rule', 'Simpson''s
 Three Eighth Rule')
title('LTE for numerical integration of 2 - x + ln(x)')
xlabel('Methods of Numerical Integration')
ylabel('Error')
% Function for Trapezoidal Rule
function fval = trapezoid(f, a, b)
    h = b - a;
```

```
    fval = h.*(f(a) + f(a + h))./2;
end
% Function for Simpson's One Third Rule
function fval = oneThird(f, a, b)
    h = (b - a)./2;
    fval = h.*(f(a) + 4.*f(a + h) + f(a + 2.*h))./3;
end
% Function for Simpson's Three Eighth Rule
function fval = threeEighth(f, a, b)
    h = (b - a)./3;
    fval = 3.*h.*(f(a) + 3.*f(a + h) + 3.*f(a + 2.*h) + f(a +
 3.*h))./8;
end
function fval = f(x)
    fval = 2 - x + log(x);
end

% Integration of Function
function fx = integratedf(x)
    fx = 2.*x - (x.^2)./2 + x.*log(x) - x;
end
```



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Question 1 - GTE

Table of Contents

Numerical integration of 2 - x + ln(x)

a = 1 and b = 2 True Value of the integration of the function from b to a

```
a = 1;
b = 2;
n = 100;
truevalue = integratedf(b) - integratedf(a);
% Calculating the error using Trapezoid Rule
x = trapezoidal(@f, a, b, n);
errTrap = abs(x - truevalue);
disp(['The error while caluclated using Trapezoidal Rule is :- ',
 num2str(errTrap)]);
% Calculating the error using Simpson's One Third Rule
x = oneThird(@f, a, b, n);
errOneThird = abs(x - truevalue);
disp(['The error while caluclated using Simpson''s One Third Rule
 is :- ', num2str(errOneThird)])
% Calculating the error using Simpson's Three Eighth Rule
x = threeEighth(@f, a, b, n);
errThreeEighth = abs(x - truevalue);
disp(['The error while caluclated using Simpson''s Three Eighth Rule
 is :- ', num2str(errThreeEighth)])
```

```
The error while caluclated using Trapezoidal Rule is :- 4.1666e-06
The error while caluclated using Simpson's One Third Rule is :-
 6.0758e-12
The error while caluclated using Simpson's Three Eighth Rule is :-
 2.7008e-12
```

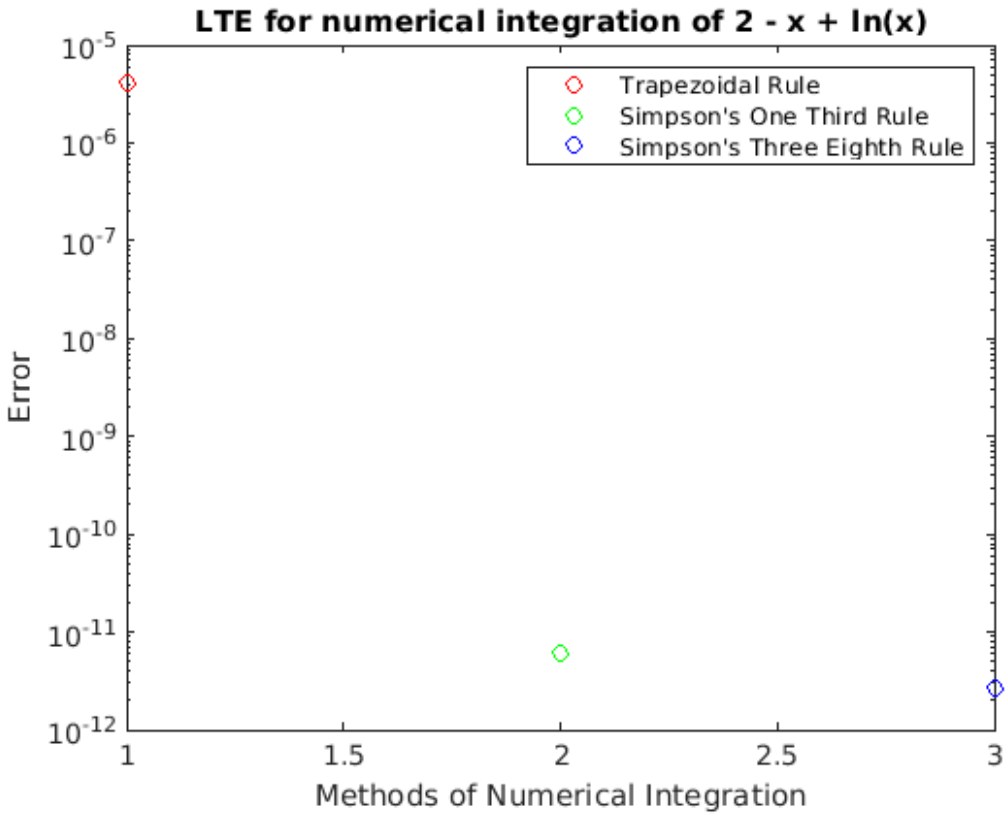
Plotings

```
semilogy(1, errTrap,'ro', 2, errOneThird, 'go', 3,
 errThreeEighth, 'bo')
legend('Trapezoidal Rule', 'Simpson''s One Third Rule', 'Simpson''s
 Three Eighth Rule')
title('LTE for numerical integration of 2 - x + ln(x)')
xlabel('Methods of Numerical Integration')
ylabel('Error')
% function for Trapezoidal Rule
function fval = trapezoidal(f, a, b, n)
    h = (b - a)./n;
    fval = 0;
    for i = 1:n
```

```
        fval = fval + h.*(f(a + (i - 1).*h) + f(a + i.*h))./2;
    end
end

% FUnction for Simpson's One Third Rule
function fval = oneThird(f, a, b, n)
    h = (b - a)./(2.*n);
    fval = 0;
    for i = 1:2:2*n
        fval = fval + h.*(f(a + (i - 1).*h) + 4.*f(a + i.*h) + f(a +
 (i + 1).*h))./3;
    end
end

% Function for Simpson's Three Eighth Rule
function fval = threeEighth(f, a, b, n)
    h = (b - a)./(3.*n);
    fval = 0;
    for i = 1:3:3*n
        fval = fval + 3.*h.*(f(a + (i - 1).*h) + 3.*f(a + i.*h) +
 3.*f(a + (i + 1).*h) + f(a + (i + 2).*h))./8;
    end
end
function fval = f(x)
    fval = 2 - x + log(x);
end
% Integration of Function
function fx = integratedf(x)
    fx = 2.*x - (x.^2)./2 + x.*log(x) - x;
end
```



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Question 2 - LTE

Table of Contents

Numerical integration of x^3 - 2x,

a = 0 and b = pi/2 True Value of the integration of the function from b to a

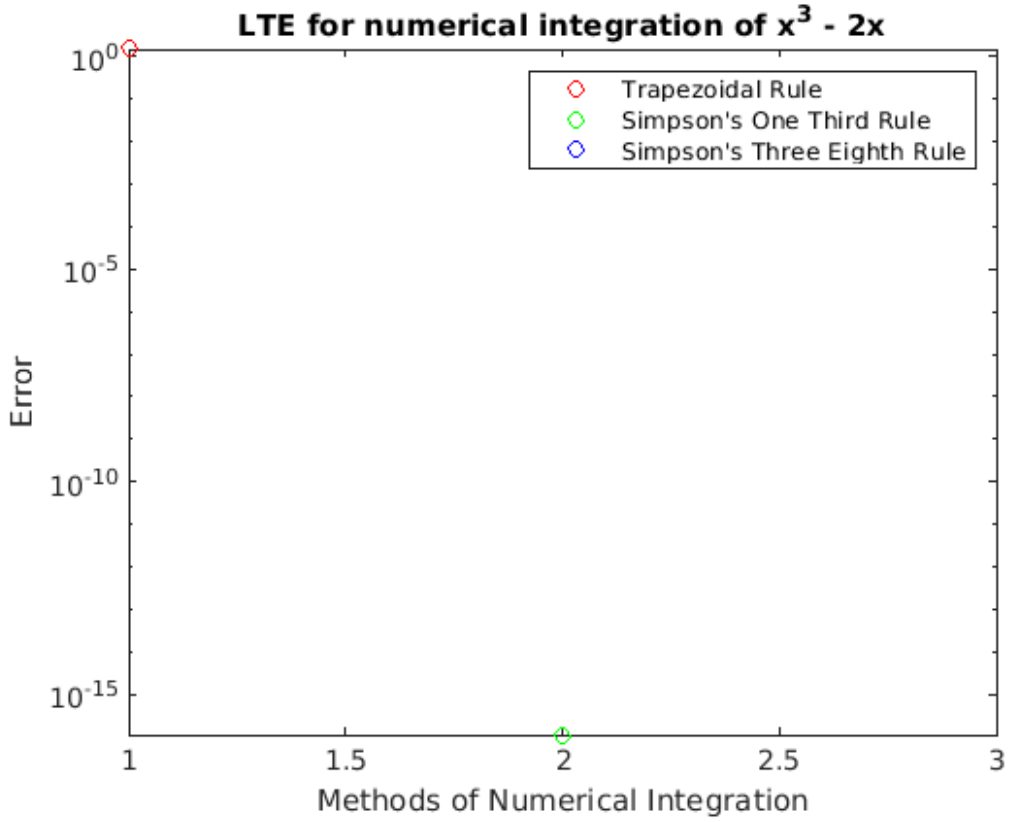
```
a = 0;
b = pi./2;
truevalue = integratedf(b) - integratedf(a);
% Calculating the error using Trapezoid Rule
x = Trapezoidal(@f, a, b);
errTrap = abs(x - truevalue);
disp(['The error using Trapezoidal Rule is : ', num2str(errTrap)]);
% Calculating the error using Simpson's One Third Rule
x = oneThird(@f, a, b);
errOneThird = abs(x - truevalue);
disp(['The error using Simpson''s One Third Rule is : ',
 num2str(errOneThird)])
% Calculating the error using Simpson's Three Eighth Rule
x= threeEighth(@f, a, b);
errThreeEighth = abs(x - truevalue);
disp(['The error using Simpson''s Three Eighth Rule is : ',
 num2str(errThreeEighth)])
```

```
The error using Trapezoidal Rule is : 1.522
The error using Simpson's One Third Rule is : 1.1102e-16
The error using Simpson's Three Eighth Rule is : 0
```

Plotings

```
semilogy(1, errTrap,'ro', 2, errOneThird, 'go', 3,
 errThreeEighth, 'bo')
legend('Trapezoidal Rule', 'Simpson''s One Third Rule', 'Simpson''s
 Three Eighth Rule')
title('LTE for numerical integration of x^3 - 2x')
xlabel('Methods of Numerical Integration')
ylabel('Error')
function fval = f(x)
    fval = x.^3 - 2.*x;
end
% Integration of Function
function fx = integratedf(x)
    fx = (x.^4)./4 - x.^2;
end
```

```
% Function for Trapezoidal Rule
function fval = Trapezoidal(f, a, b)
    h = b - a;
    fval = h.*(f(a) + f(a + h))./2;
end
% Function for Simpson's One Third Rule
function fval = oneThird(f, a, b)
    h = (b - a)./2;
    fval = h.*(f(a) + 4.*f(a + h) + f(a + 2.*h))./3;
end
% Function for Simpson's Three Eighth Rule
function fval = threeEighth(f, a, b)
    h = (b - a)./3;
    fval = 3.*h.*(f(a) + 3.*f(a + h) + 3.*f(a + 2.*h) + f(a +
 3.*h))./8;
end
```



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Question 2 - GTE

Table of Contents

Numerical integration of x^3 - 2x,

a = 0 and b = pi/2 True Value of the integration of the function from b to a

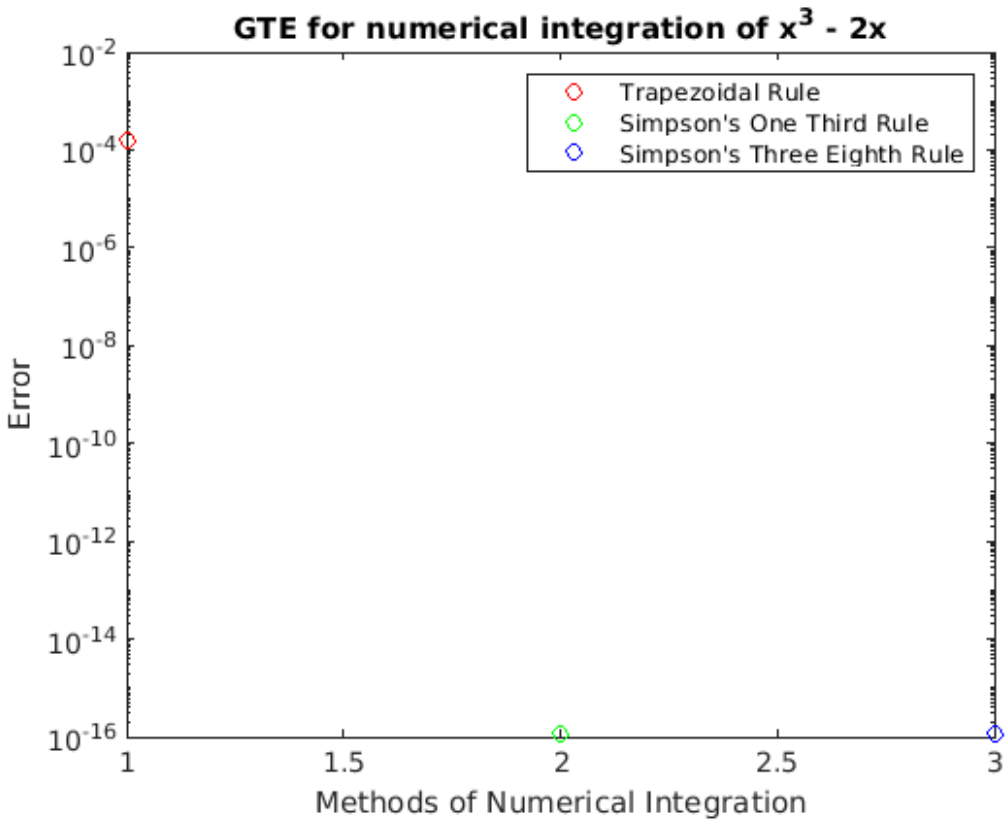
```
a = 0;
b = pi./2;
n = 100;
truevalue = integratedf(b) - integratedf(a);
% Calculating the error using Trapezoid Rule
x = trapezoidal(@f, a, b, n);
errTrap = abs(x - truevalue);
disp(['The error caluclated while using Trapezoidal Rule is :- ',
 num2str(errTrap)]);
% Calculating the error using Simpson's One Third Rule
x = oneThird(@f, a, b, n);
errOneThird = abs(x - truevalue);
disp(['The error caluclated while using Simpson''s One Third Rule
 is :- ', num2str(errOneThird)])
% Calculating the error using Simpson's Three Eighth Rule
x = threeEighth(@f, a, b, n);
errThreeEighth = abs(x - truevalue);
disp(['The error caluclated while using Simpson''s Three Eighth Rule
 is :- ', num2str(errThreeEighth)])
```

```
The error caluclated while using Trapezoidal Rule is :- 0.0001522
The error caluclated while using Simpson's One Third Rule is :-
 1.1102e-16
The error caluclated while using Simpson's Three Eighth Rule is :-
 1.1102e-16
```

Plotings

```
semilogy(1, errTrap,'ro', 2, errOneThird, 'go', 3,
 errThreeEighth, 'bo')
legend('Trapezoidal Rule', 'Simpson''s One Third Rule', 'Simpson''s
 Three Eighth Rule')
title('GTE for numerical integration of x^3 - 2x')
xlabel('Methods of Numerical Integration')
ylabel('Error')
function fval = f(x)
    fval = x.^3 - 2.*x;
end
% Integration of Function
function fx = integratedf(x)
```

```
    fx = (x.^4)./4 - x.^2;
end
% Function for Trapezoidal Rule
function fval = trapezoidal(f, a, b, n)
    h = (b - a)./n;
    fval = 0;
    for i = 1:n
        fval = fval + h.*(f(a + (i - 1).*h) + f(a + i.*h))./2;
    end
end
% Function Simpson's One Third Rule
function fval = oneThird(f, a, b, n)
    h = (b - a)./(2.*n);
    fval = 0;
    for i = 1:2:2*n
        fval = fval + h.*(f(a + (i - 1).*h) + 4.*f(a + i.*h) + f(a +
 (i + 1).*h))./3;
    end
end
% Function Simpson's Three Eighth Rule
function fval = threeEighth(f, a, b, n)
    h = (b - a)./(3.*n);
    fval = 0;
    for i = 1:3:3*n
        fval = fval + 3.*h.*(f(a + (i - 1).*h) + 3.*f(a + i.*h) +
 3.*f(a + (i + 1).*h) + f(a + (i + 2).*h))./8;
    end
end
```



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Question-1(d)

Table of Contents

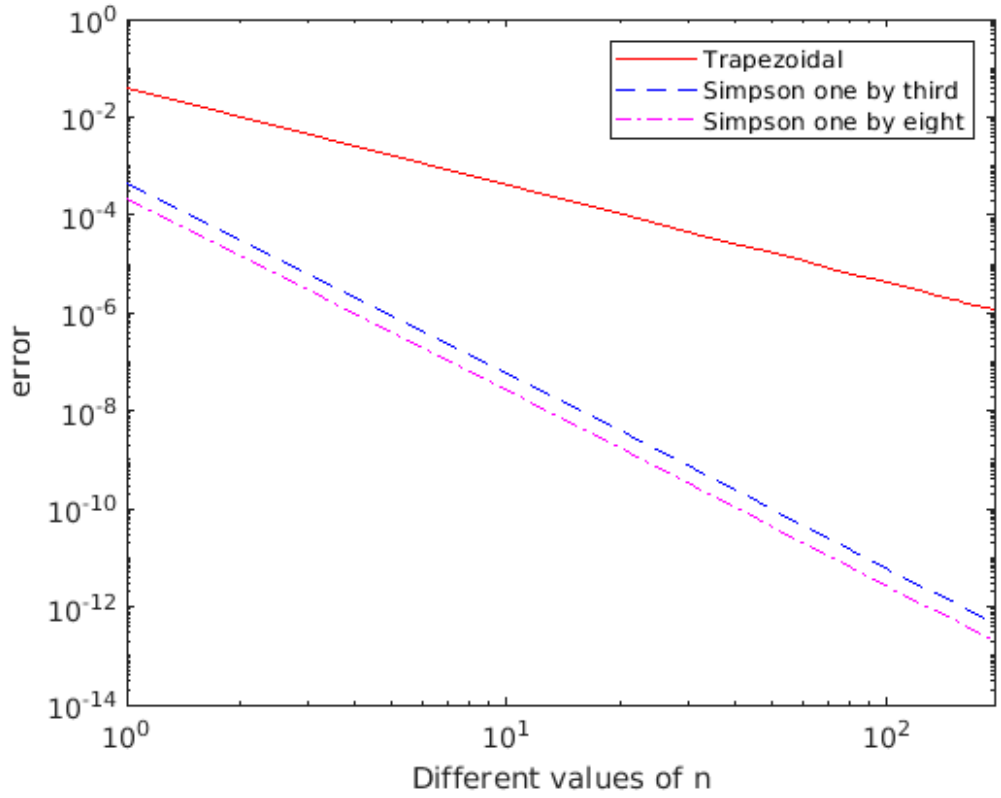
Varing the number of intervals for 2-x+log(x)

```
a=1;
b=2;
n=[1:10:200];
truevalue=b-b^2/2+b*log(b)-(a-a^2/2+a*log(a));
for z=1:20
% Trapezoidal Rule
h=(b-a)/n(z);
vec=[a:h:b];
funvec=2-vec+log(vec);
sumfun=zeros(1,100);
for i=1:n(z)
sumfun(i)=h/2*(funvec(i)+funvec(i+1));
end
I_Trap=sum(sumfun);
err_Trap(z)=abs(truevalue-I_Trap);
% Simpson's one by third Rule
h=(b-a)/(2*n(z));
vec=[a:h:b];
funvec=2-vec+log(vec);
sumfun=zeros(1,200);
for i=1:2:2*n(z)-1
sumfun(i)=h/3*(funvec(i)+4*funvec(i+1)+funvec(i+2));
end
I_sim1=sum(sumfun);
err_sim1(z)=abs(truevalue-I_sim1);
% Simpson's one by eight Rule
h=(b-a)/(3*n(z));
vec=[a:h:b];
funvec=2-vec+log(vec);
sumfun=zeros(1,300);
for i=1:3:3*n(z)-2
sumfun(i)=(3*h)/8*(funvec(i)+3*funvec(i+1)+3*funvec(i+2)+funvec(i+3));
end
I_sim2=sum(sumfun);
err_sim2(z)=abs(truevalue-I_sim2);
end
```

plotings

```
loglog(n,err_Trap,'-r',n,err_sim1,'--b',n,err_sim2,'-.m');
```

```
legend('Trapezoidal','Simpson one by third','Simpson one by eight');
xlabel('Different values of n');
ylabel('error');
```



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Question-1(d)

Table of Contents

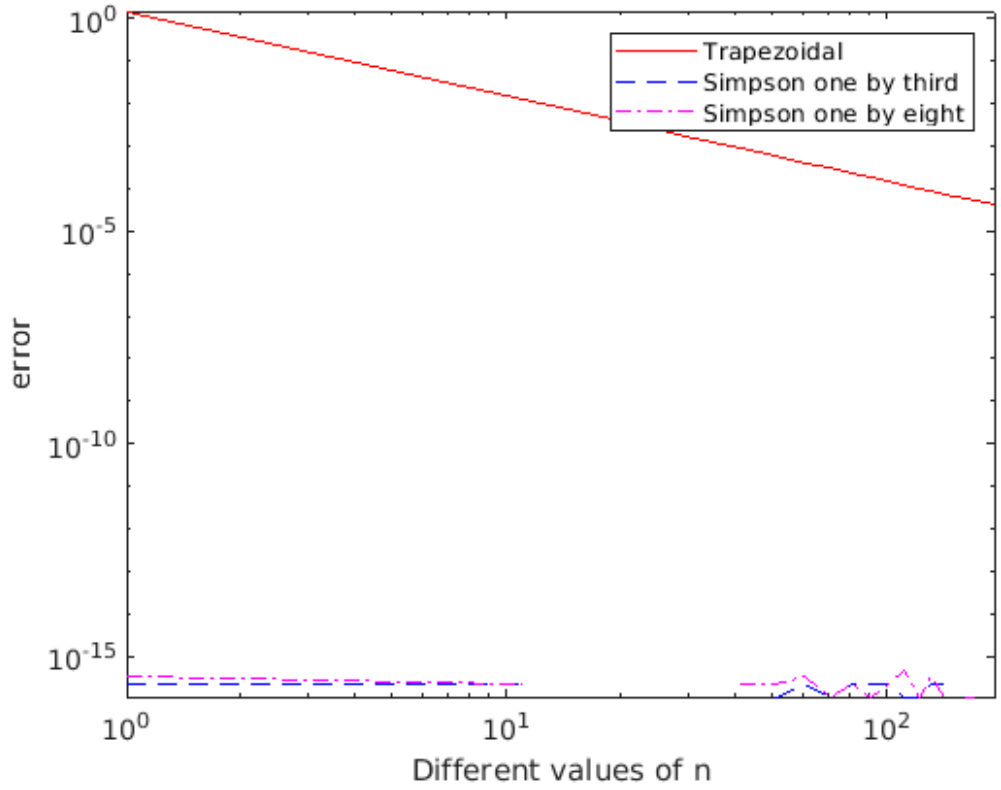
Varing the number of intervals for x^3-3x

```
a=0;
b=pi/2;
n=[1:10:200];
truevalue=(b^4)/4-b^2-((a^4)/4-a^2);
for z=1:20
% Trapezoidal Rule
h=(b-a)/n(z);
vec=[a:h:b];
funvec=vec.^3-2.*vec;
sumfun=zeros(1,100);
for i=1:n(z)
sumfun(i)=h/2*(funvec(i)+funvec(i+1));
end
I_Trap=sum(sumfun);
err_Trap(z)=abs(truevalue-I_Trap);
% Simpson's one by third Rule
h=(b-a)/(2*n(z));
vec=[a:h:b];
funvec=vec.^3-2.*vec;
sumfun=zeros(1,200);
for i=1:2:2*n(z)-1
sumfun(i)=h/3*(funvec(i)+4*funvec(i+1)+funvec(i+2));
end
I_sim1=sum(sumfun);
err_sim1(z)=abs(truevalue-I_sim1);
% Simpson's one by eight Rule
h=(b-a)/(3*n(z));
vec=[a:h:b];
funvec=vec.^3-2.*vec;
sumfun=zeros(1,300);
for i=1:3:3*n(z)-2
sumfun(i)=(3*h)/8*(funvec(i)+3*funvec(i+1)+3*funvec(i+2)+funvec(i+3));
end
I_sim2=sum(sumfun);
err_sim2(z)=abs(truevalue-I_sim2);
end
```

plotings

```
loglog(n,err_Trap,'-r',n,err_sim1,'--b',n,err_sim2,'-.m');
```

```
legend('Trapezoidal','Simpson one by third','Simpson one by eight');
xlabel('Different values of n');
ylabel('error');
```



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Question-1(d) :

Comment on Observations:

- For small value of h is error value will be large and large value of h error will be small. When interval will be increases the error will be decreases