EE:211

Computational Techniques in Electrical Engineering

Lab#3

Numerical Integration: Implementing Trapezoidal Rule in Matlab

- The trapezoidal rule as discussed in class is given as

$$I(f) = \int_a^b f(x)dx \approx T_n(f) = \frac{h}{2}[f(x_0) + f(x_n)] + h[f(x_1) + f(x_2) + \cdots\cdots\cdots + f(x_{n-1})]$$

Here $a = x_0$ and $b = x_n$ and $h = \frac{b-a}{n}$, $\quad x_j = a + jh \qquad j = 0,1,2,\cdots n$

- The following file trapezoidal.m implements the trapezoidal rule in Matlab

```
function [integral] = trapezoidal(index_f,a,b,n)

% function to calculate the integral using trapezoidal rule
% input parameters:
%   index_f: parameter for the integrand
%   a: lower limit
%   b: upper limit
%   n: Number of intervals must be positive integer greater than or equal
%   to 1
%

% output parameter: integral

% sum the endpoints
sumend =( f(a,index_f) + f(b,index_f))/2; % f is a function which contains
                                          % multiple integrands

h = (b-a)/n; % size of interval
sum = 0;
if ( n > 1)

    for j = 1:1:n-1
        xj = a + j*h;
        sum = sum + f(xj,index_f);
    end
end
```

```
integral = h*(sumend + sum);


function f_value = f(x,index)

% this function defines the integrand

switch index
    case 1
        f_value = exp(-x.^2);
    case 2
        f_value = 1./(1+x.^2);
end
```

- Read the **m** file carefully and make sure you understand all the Matlab commands
- Run this function by writing a script file (e.g. main.m). A sample script file is as follows:

```
clear all

a = 0;
b = 1;
n = 1;
index_f = 1


integral = trapezoidal(index_f,a,b,n)
```

- Run this script file to calculate the integral of $I = \int_0^1 e^{-x^2}\,dx \approx 0.746824132812427$, as given on page 193 of your textbook and fill in the following table

Number of interval (n)	Step size (h)	Tn(f)	Error
1			
2			
4			
8			
16			
32			
64			
128			

- Modify your script file to generate the table 5.1, page 194 of your textbook. A sample script file is as follows.

```
clear all
```

```
a = 0;
b = 1;
n = 1;
index_f = 1

n1 = [ 2 4 8 16 32 64 128];

for q = 1:length(n1)
    n = n1(q);
    integral(q) = trapezoidal(index_f,a,b,n);
end

trueval = 0.746824132812427;
err = trueval - integral
y = [n1; err];

fprintf(1,'%6.2f  %12.8f\n',y);
```

- Plot the error versus n, i.e., plot(n1,err,'-o')
- Repeat the above exercises for the integrals given on page 193 of your textbbok. Note you will have to change the trapezoidal.m file to add the new integrand.