EE:211

Computational Techniques in Electrical Engineering

Lab#3 (Part 2)

Numerical Integration#2: Implementing Simpson Rule in Matlab

- The Simpson rule as discussed in class is given as

$$I(f) = \int_a^b f(x)dx \approx S_n(f)$$
$$= \frac{h}{3}[f(x_0) + 4f(x_1) + 2f(x_2) + \cdots\cdots\cdots + 2f(x_{n-2}) + 4f(x_{n-1}) + f(x_n)]$$

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 simpson.m implements the Simpson's rule in Matlab

```
function [integral]=simpson(index_f,a,b,n)
%
%  function [integral]=simpson(a,b,n0,index_f)
%
%  function to calculate the integral using Simpson rule
% input parameters:
%   index_f: parameter for the integrand
%   a: lower limit
%   b: upper limit
%   n: Number of intervals must be positive even integer greater than or %
%equal to 2
%

% output parameter:integral



% Initialize for Simpson integration.
sumend = f(a,index_f) + f(b,index_f);
sumodd = 0;
sumeven = 0;

% For case of n=2
if(n == 2)
    h = (b-a)/n;
```

```
    k=1;
    sumodd1 = f(a+k*h,index_f);
    integral= h*(sumend + 4*sumodd1)/3;    %%%% this will calculate the
integeral
end

%% For case of n > 2.
if(n > 2)
    h = (b-a)/n;
    for i=2:2:n-2
        sumeven = sumeven + f(a+i*h,index_f);
    end

    for k=1:2:n-1
        sumodd = sumodd + f(a+k*h,index_f);
    end
    integral= h*(sumend + 4*sumodd + 2*sumeven)/3;    %%%% this will
caluclate the integeral
end


%
% This defines the integrand.
function f_value = f(x,index)

switch index
case 1
    f_value = exp(-x.^2);
case 2
    f_value = 1 ./(1+x.^2);
case 3
    f_value = 1 ./(2+sin(x));
case 4
    f_value = exp(cos(x));
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 = simpson(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 198 of your textbook and fill in the following table

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

- Modify your script file to generate the table 5.2, page 198 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) = simpson(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 198 of your textbook. Note you will have to change the simpson.m file to add the new integrand.