

NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

# ASSIGNMENT 5

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APPLIED COMPUTATIONAL METHODS IN  
MECHANICAL SCIENCES

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ASSIGNMENT ON GOLDEN SECTION SEARCH METHOD, NEWTON'S METHOD

## Answer

$$A = 4 \sin(\theta) (1 + \cos(\theta)) = 4 \sin(\theta) + 2 \sin(2\theta)$$

$$A' = 4(\cos(\theta) + \cos(2\theta))$$

$$A'' = -4(\sin(\theta) + 2 \sin(2\theta))$$

A function is written to evaluate the above expressions since they'll be used in the main program several times.

## Code(C++)

```
1  #include<iostream>
2  #include<cmath>
3  #include<time.h>
4  #define pi 3.14159
5  using namespace std;
6  double Area(float theta,int index)
7  {
8      switch (index)
9      {
10         case 0:return(4*sin(theta)+2*sin(2*theta));break;//Area
11         case 1:return(4*(cos(theta)+cos(2*theta)));break;//first
derivative
12         case 2:return(-4*(sin(theta)+2*sin(2*theta)));break;//second
derivative
13     }
14 }
15 main()
16 {
17     clock_t start=clock();
18     int choice=0,itrn=0;
19     float x;
20     if(!choice)
21     {
22         cout<<"GOLDEN SECTION SEARCH METHOD\n";
23         float x1=0,xu=pi/2,d,x1,x2;
24         while((xu-x1)>0.05)
25         {
26             ++itrn;
27             d=(sqrt(5)-1)*(xu-x1)/2;
28             x1=x1+d;
29             x2=xu-d;
30             if(Area(x1,0)>Area(x2,0))
31                 x1=x2;
32             else
33                 xu=x1;
34         }
35         x=(xu+x1)/2;
36     }
37     else
38     {
39         cout<<"NEWTON'S METHOD\n";
40         float x0;x=pi/4;
41         do
42         {
43             ++itrn;
44             x0=x;
45             x=x-(Area(x,1)/Area(x,2));
```

```

46         }while (abs (x-x0)>0.05);
47     }
48     cout<<"Angle in degrees:"<<x*180/pi<<"\nIterations:"<<itrn<<"\nMax
Area:"<<Area(x,0);
49     clock_t stop=clock();
50     double timespent = (double) (stop-start)/(double)CLOCKS_PER_SEC;
51     cout<<"\nCPU Time:"<<timespent<<" seconds";
52 }

```

## Output

```

GOLDEN SECTION SEARCH METHOD
Angle in degrees:59.6807
Iterations:8
Max Area:5.19599
CPU Time:0.003 seconds

```

```

NEWTON'S METHOD
Angle in degrees:60
Iterations:2
Max Area:5.19615
CPU Time:0.001 seconds

```

When  $\theta = 60^\circ$ , let us evaluate the value of  $A''$ . If it is negative, then the evaluated angle gives the maximum area.

$$A'' = -4(\sin(60) + \sin(120)) = -4(0.866 + 0.866) = -6.93 < 0.$$