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MATH 4670
October 6, 2005

1 Section 2.4, Problem 4.d.

Using the Secant method, we will find solutions accurate to within 10^{-5} for the equation

$$\sin x - e^{-x} = 0$$

on the intervals $[0, 1]$, $[3, 4]$, and $[6, 7]$.

2 Source Code

The following C code can be used to find an accurate value:

```
#include <stdlib.h>
#include <math.h>

#define E 2.71828182846
double f(double x);
void secant_method(double a, double b);

int main()
{
   secant_method(0, 1);
   secant_method(3, 4);
   secant_method(6, 7);
   return 0;
}

double f(double x)
{
   return sin(x) - pow(E, -x);
}

void secant_method(double a, double b)
{
   double x[100];
   unsigned int k = 1;
   x[0] = a;
   x[1] = b;

   printf("%d \t %5.20f \t %5.20f \n", 0, x[0], f(x[0]) );
   printf("%d \t %5.20f \t %5.20f \n", 1, x[1], f(x[1]) );
```

```
   while( f(x[k]) != f(x[k-1]) )
   {
        x[k+1] = x[k] - ( f(x[k]) * (x[k] - x[k-1]) ) / ( f(x[k]) - f(x[k-1]) );
        printf("%d \t %5.20f \t %5.20f \n", k+1, x[k+1], f(x[k+1]) );
        k++;
   }
   printf("\n");
}
```

3 Results

```
           x                                   f(x)
-------------------------------------------------------------------
0        0.00000000000000000000          -1.00000000000000000000
1        1.00000000000000000000          0.47359154363658340081
2        0.67861410057509097271          0.12039518359033574146
3        0.56906225140104915727          -0.02721368799771151092
4        0.58925961359832335074          0.00100780020987234487
5        0.58853835801776854808          0.00000778607402973641
6        0.58853274234780617036          -0.00000000226615159971
7        0.58853274398178201388          0.00000000000000499600
8        0.58853274398177846116          0.00000000000000022204
9        0.58853274398177835014          0.00000000000000000000
10       0.58853274398177835014          0.00000000000000000000

-------------------------------------------------------------------
0        3.00000000000000000000          0.09133293969205572016
1        4.00000000000000000000          -0.77511813419663666558
2        3.10541038316468043234          -0.00863175087384851492
3        3.09533600366510075474          0.00098035352374799267
4        3.09636350534771409571          0.00000040731731395377
5        3.09636393243159124822          -0.00000000001992754572
6        3.09636393241069773907          -0.00000000000000006939
7        3.09636393241069773907          -0.00000000000000006939


-------------------------------------------------------------------
0        6.00000000000000000000          -0.28189425037558701881
1        7.00000000000000000000          0.65607471675323680849
2        6.30053686236388088560          0.01551536530789358360
3        6.28359475375935794261          -0.00145723170184712644
4        6.28504936779046197159          0.00000009458368851870
5        6.28504927338280516835          0.00000000000022315591
6        6.28504927338258223557          -0.00000000000000019190
```

```
7        6.28504927338258223557              -0.00000000000000019190
```

4 Summary

It is clearly shown that x converges to approximately 0.58853274398177835014 on the interval $[0, 1]$, 3.09636393241069773907 on $[3, 4]$ and to approximately 6.28504927338258223557 on $[6, 7]$.