Engineering Math Assignment II

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If the maximum percentage absolute error is desired to be 1E-9, using the newton repulsion iteration method and initial ~~given~~ value of 0.5, find the root of the function given below

$f(x) = e^{-0.5x}(4-x) - 2$

Solution

$f(x) = e^{-0.5x}(4-x) - 2$

$f'(x) = -e^{-0.5x} - 0.5e^{-0.5x}(4-x)$

$f'(x) = -e^{-0.5x} - 2e^{-0.5x} + 0.5xe^{-0.5x}$

$f(x) = e^{-0.5x}(4-x) - 2$

$f'(x) = 0.5xe^{-0.5x} - 3e^{-0.5x}$

~~$x_{i+1} = x_i$~~

$$x_{i+1} = x_i - \frac{f(x_i)}{f'(x_i)}$$

where $x = 0.5$

$$x_1 = 0.5 - \left(\frac{e^{-0.5\times0.5}(4-0.5) - 2}{(0.5\times0.5e^{-0.5\times0.5}) - (3e^{0.5\times0.5})} \right)$$

$x_1 = 0.858890$

$$x_2 = 0.858890 - \left(\frac{e^{-0.5\times0.858890}(4-0.858890) - 2}{(0.5\times0.858890e^{-0.5\times0.858890}) - (3e^{-0.5\times0.858890})} \right)$$

$= 0.884496$

$$x_3 = 0.884496 - \left(\frac{e^{-0.5\times0.884496}(4-0.884496) - 2}{(0.5\times0.884496e^{-0.5\times0.884496}) - (3e^{-0.5\times0.884496})} \right)$$

$= 0.88570$

When $x = 0.88570$

$$x_4 = 0.88570 - \left(\frac{e^{-0.5 \times 0.88570} (4 - 0.88570) - 2}{(0.5 \times 0.88570 e^{-0.5 \times 0.88570}) - (3e^{-0.5 \times 0.88570})} \right)$$

$$= 0.88571$$

When $x_4 = 0.88571$

$$x_5 = 0.88571 - \left(\frac{e^{-0.5 \times 0.88571} (4 - 0.88571) - 2}{(0.5 \times 0.88571 e^{-0.5 \times 0.88571}) - (3e^{-0.5 \times 0.88571})} \right)$$

$$= 0.88571$$

When $x_5 = 0.88571$

$$x_6 = 0.88571 - \left(\frac{e^{-0.5 \times 0.88571} (4 - 0.88571) - 2}{(0.5 \times 0.88571 e^{-0.5 \times 0.88571}) - (3e^{-0.5 \times 0.88571})} \right)$$

$$= 0.88571$$

For error

$$\varepsilon_a = \left| \frac{x_{i+1} - x_i}{x_{i+1}} \right| \times 100$$

$$\varepsilon_1 = \frac{0.888890 - 0.5}{0.888890} \times 100 = 40.897\%$$

$$\varepsilon_{a2} = \frac{0.88496 - 0.858890}{0.858890} \times 100 = 5.205\%$$

~~$\varepsilon_{a3} = \frac{0.88571 - 0.88570}{0.88571} \times 100 = 2.224 \times 10^{-3}\%$~~

$$\varepsilon_{a3} = \frac{0.88570 - 0.88496}{0.88570} \times 100 = 0.0849\%$$

$$\varepsilon_{a4} = \frac{0.88571 - 0.88570}{0.88571} \times 100 = 2.224 \times 10^{-3}\%$$

$$\varepsilon_{a5} = \frac{0.88571 - 0.88571}{0.88571} \times 100 = 0\%$$

i	x	ε_a (%)
0	0.5	40.597
1	0.838890	5.205
2	0.88496	0.0849
3	0.88570	2.224×10^{-5}
4	0.88571	0
5	0.88571	0

MathLab Code

```
commandwindow
clear
clc
format short g
syms x
a=(exp(-0.5*x)*((4-x)))-2
b=diff(a)
x=0.5;
xa=x
for i=1:5
    iter(i+1)=i
    x= double(subs(x-(a/b)))
    xa(i+1)=x
    ea(i+1)=abs(( xa(i+1)-xa(i))/xa(i+1))*100
    if ea(i+1)<=1E-9
        break
    end
end
tab=[iter' ea' xa']
```

Output

a =

- exp(-x/2)*(x - 4) - 2

b =

(exp(-x/2)*(x - 4))/2 - exp(-x/2)

xa =

0.5

iter =

0 1

x =

0.83889

xa =

0.5 0.83889

ea =

0 40.397

iter =

```
    0     1     2

x =

    0.88496

xa =

       0.5     0.83889     0.88496

ea =

         0      40.397      5.2054

iter =

    0     1     2     3

x =
```

0.88571

xa =

0.5 0.83889 0.88496 0.88571

ea =

0 40.397 5.2054 0.084972

iter =

0 1 2 3 4

x =

0.88571

xa =

0.5 0.83889 0.88496 0.88571 0.88571

ea =

0 40.397 5.2054 0.084972 2.2247e-05

iter =

0 1 2 3 4 5

x =

0.88571

xa =

0.5 0.83889 0.88496 0.88571 0.88571 0.88571

ea =

```
         0      40.397      5.2054     0.084972   2.2247e-05   1.5293e-12


tab =


         0           0         0.5
         1      40.397      0.83889
         2      5.2054      0.88496
         3    0.084972      0.88571
         4   2.2247e-05      0.88571
         5   1.5293e-12      0.88571


>>
```