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15/ENG04/049
Elect/Elect ENG

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

Initial guess value of 0.5

maximum percentage absolute error = 1E-9

find the root of the function.

Soln

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

To find the root

when $x=0$, $f(x)=2$

$x=1$, $f(x) = -0.180$

$\therefore x \in (0, 1)$

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

$f'(x)$ = Expanding

$4e^{-0.5x} - xe^{-0.5x} - 2$

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

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

$= -2e^{-0.5x} + 0.5xe^{-0.5x} - e^{-0.5x}$

factorizing

$= (-2-1)e^{-0.5x} + 0.5xe^{-0.5x}$

$= -3e^{-0.5x} + 0.5xe^{-0.5x}$

$= e^{-0.5x}[0.5x-3]$

using Newton-Raphson method;

$$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$$

percentage absolute error = [final value − initial value] × 100

Or

percentage absolute error = $[x_{n+1} - x_n] \times 100$

for iteration 1;

let $x_n = 0.5$

$f(x_n) = (4-0.5)e^{-0.5\times0.5} - 2$

$= 0.7258027407$

$f'(x_n) = e^{-0.5\times0.5}[(0.5\times0.5)-3]$

$= -2.1417$

$\therefore x_{n+1} = 0.5 - \dfrac{0.7258027407}{-2.141702153}$

$= 0.5 + \dfrac{0.7258027407}{2.141702153}$

$= 0.8388906061$

% Absolute error $= (x_{n+1} - x_n) \times 100$

$= (0.838890606\text{1} - 0.5) \times 100$

$= 33.8890606\text{1}$

for iteration 2;

$x_n = x_{n+1}$

$= 0.8388906061$

$\therefore f(x_n) = (4 - 0.83889060\text{11}) e^{-0.5 \times 0.8388906061} - 2$

$= 0.0781492 9777$

$f'(x_n) = e^{-0.5 \times 0.8388906061} [(0.5 \times 0.8388906061) - 3]$

$= -1.696486032$

$\therefore x_{n+1} = x_n - \dfrac{f(x_n)}{f'(x_n)}$

$= 0.838906061 - \dfrac{0.07814929777}{-1.696486032}$

$= 0.838906061 + \dfrac{0.07814929777}{1.696486032}$

$= 0.884971 4552$

% Absolute error $= (0.8849714552 - 0.8388906061) \times 100$

$= 4.6080849 1$

for iteration 3;

$x_n = x_{n+1}$

$= 0.8849714552$

$\therefore f(x_n) = (4 - 0.8849714552) e^{-0.5 \times 0.884971 552} - 2$

$= 0.001211085128$

$f'(x_n) = e^{-0.5 \times 0.8849714552} [(0.5 \times 0.8849714552) - 3]$

$= -1.643043101.$

$\therefore x_{n+1} = 0.8849714552 - \dfrac{0.001211085128}{-1.643043101}$

$= 0.884971452 + \frac{0.001211085128}{1.6480431 01}$

$= 0.885708554$

% Absolute error $= (0.885708554 - 0.884971452) \times 100$

$= 0.07370988$

for iteration 4;

$x_n = x_{n+1}$

$= 0.885708554$

$\therefore f(x_n) = (4 - 0.885708554)\, e^{-0.5 \times 0.885708554} - 2$

$= 4.0727366 \times 10^{-7}$

$f'(x_n) = e^{-0.5 \times 0.885708554} [(0.5 \times 0.885708554) - 3]$

$= -1.642200987$

$x_{n+1} = 0.885708554 - \frac{4.0727366 \times 10^{-7}}{-1.642200987}$

$= 0.883708554 + \frac{4.0727366 \times 10^{-7}}{-1.642200987}$

$= 0.885708802$

% absolute error $= (0.885708802 - 0.885708554) \times 100$

$= 2.48 \times 10^{-5}$

for iteration 5

$x_n = x_{n+1}$

$= 0.885708802$

$f(x_n) = (4 - 0.885708802)\, e^{-0.5 \times 0.885708802} - 2$

$= 7.84 \times 10^{-12}$

$f'(x_n) = e^{-0.5 \times 0.885708802} - [(0.5 \times 0.885708802) - 3]$

$= -1.64200704$

$x_{n+1} = 0.885708802 - \frac{7.84 \times 10^{-12}}{1.642200704}$

$= 0.885708802 + \frac{7.84 \times 10^{-12}}{1.642200704}$

$= 0.883708802$

% absolute error $= (0.885708802 - 0.885708802) \times 100$

$= 0$

n	x_n	$f(x_n)$	$f'(x_n)$	x_{n+1}	% absolute error
1	0.5	0.7258027407	-2.1417	0.8388906067	33.8890606[illegible]
2	0.8388906661	0.07814929777	-1.6964.86032	0.8849714552	4.6080849
3	0.8849714552	0.001211085128	-1.643043101	0.885708334	0.07370988
4	0.885708334	4.072366×10^{-7}	-1.64220987	0.88570802	2.48×10^{-5}
5	0.88578802	7.84×10^{-12}	-1.642200704	0.88570882	0

2) MATLAB CODE

Command Window

```
clear
clc
inter = 0;
u = 18;
for i = (1:inf)
iter(i+1) = i;
f(t) = ((0.3*u(i)^2)/(500+(log(u(i))^3))) - 0.02*u(i);
ft = (3*u(i))/((5*(log/(u(i))^3 + 500)) - (9*u(i)*log(u(i))
/(10*log(u(i)^3+500)^2 - 1/50;
u(i+1) = u(i) - (f+/ft);
ea = abs(u(i+1)-u(i))*100;
if ea(i+1)>1e-15
Break
end
end
tab = [iter(v' ea')];
```