EQUATION OF THE DERIVATIVE OF THE FUNCTION TO SOLVE EQUATIONS

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Abstract. *This article presents approximate calculations using the exact integral*
Keywords: *integral, equality, inequality.*

УРАВНЕНИЕ ПРОИЗВОДНОЙ ФУНКЦИИ ДЛЯ РЕШЕНИЯ УРАВНЕНИЙ

Аннотация. *В данной статье представлены приближенные расчеты с использованием точного интеграла*
Ключевые слова: *интеграл, равенство, неравенство.*

INTRODUCTION

Let us be given a non-standard equation in the form of some kind of $f(x)=0$ in section $[a,b]$. Let it be required to find the solution of this equation in Section $[a,b]$ (if it exists) ε in accuracy.

MATERIALS AND METHODS

First of all, we check whether the function $f(x)$ satisfies the conditions of Baltsano-Cauchy theorem 1 in the section $[a,b]$ or not.

Theorem one of Balsano-Koshi. If the function $f(x)$ is defined on the section $[a,b]$ and is continuous and has different sign value at the extreme points of the interval, then there exists a point $c \in (a,b)$ such that $f(c)=0$.

So, if the function $f(x)$ fulfills the conditions of the theorem, then the section $[a,b]$ contains the solution of the equation $f(x)=0$.

RESULTS

Suppose that the section $[a,b]$ contains the root of the equation $f(x)=0$. That is, let $x \in [a,b]$ exist such that $f(x)=0$ is equal. Also let $x = a + \Delta x$ be. Then the equality $f(a+\Delta x)=0$ holds. If we consider the equation $f(x_0+\Delta x) \approx f(x_0) + f'(x_0)\cdot \Delta x$,

$f(a+\Delta x) \approx f(a) + f'(a)\cdot \Delta x \approx 0$ equality, that is, $\Delta x \approx -\dfrac{f(a)}{f'(a)}$ is formed. From this, if we consider the equality $\Delta x = a - x$,

$x - a \approx -\dfrac{f(a)}{f'(a)}, \qquad x \approx a - \dfrac{f(a)}{f'(a)}$ equalities are formed.

If the equality $\left| -\dfrac{f(a)}{f'(a)} \right| < \varepsilon$ is fulfilled, the solution of the equation will be found approximately with accuracy ε.

Suppose that this inequality does not hold, then we denote $a-\frac{f(a)}{f'(a)}$ by x_1 and consider the equation in the interval $[x_1,b]$. Denote the root of the equation as $x=x_1+\Delta x$ and calculate $x\approx x_1-\frac{f(x_1)}{f'(x_1)}$. If we denote it as x_2 and $|x_2-x_1|<\varepsilon$ then $x_1+\Delta x$ is the root. Continuing in this way, after a finite step, the inequality $|x_n-x_{n-1}|<\varepsilon$ is satisfied and x_n is taken to be an approximate solution of the given equation around ε.

Example 1. Prove that the equation $f(x)=x^3-3x-6$ has a unique solution in the interval $[2;3]$ and find it with precision 0.001.

DISCUSSION

Solving. $f(x)=x^3-3x-6$ is a function defined on the interval $[2;3]$, continuous and $f(2)=-4<0$, $f(3)=12>0$. On the other hand $\forall x=(2;3)$ for $f'(x)=3(x^2-1)>0$, that is, the function is increasing. Therefore, the equation $x^3-3x-6=0$ has a unique solution in the interval $[2;3]$. Now let's say $x=2+\Delta x$ and find Δx such that $f(x)=f(2+\Delta x)=0$. For sufficiently small Δx

$$f(2+\Delta x)=f(2)+\Delta f(2)\approx f(2)+f'(2)\cdot\Delta x.$$

Then we come to the equation $f(2)+f'(2)\cdot\Delta x\approx 0$. By finding $\Delta x\approx-\frac{f(2)}{f'(2)}$ from this, we find the equation $x=2+\Delta x\approx 2-\frac{f(2)}{f'(2)}$ for the solution. Finally, taking into account that $f(2)=-4$, $f'(2)=(3x^2-3)\big|_{x=2}=9$, we find $x\approx x_1=2-\frac{-4}{9}=2.4$. Using the same reasoning, we find the solution:

$$x_2=2.4-\frac{f(2.4)}{f'(2.4)}=2.4-\frac{0.62}{14,28}\approx 2.360, \qquad |x_2-x_1|=0.40>0.001;$$

$$x_3=2.360-\frac{f(2.360)}{f'(2.360)}\approx 2.356, \qquad |x_3-x_2|=0.004>0.001;$$

$$x_4=2.356-\frac{f(2.356)}{f'(2.356)}\approx 2.356, \qquad |x_4-x_3|=0.000<0.001.$$

CONCLUSION

Therefore, the number 2.356 is the solution of the equation with an accuracy of 0.001.

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