# DARAJALI QATORLAR YORDAMIDA FUNKSIYA QIYMATINI TAQRIBIY HISOBLASH.

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**Annotatsiya**

Taqribiy hisoblash — matematikaning eng muhim tushinchalaridan biri. Funksiyalarning nuqtadagi qiymatlarini topish va bunda darajali qatordan foydalanish bizga katta qulayliklar olib keladi.

**Kalit so'zlar:** Darajali qator, qismiy yig'indi, qoldiq, ablolyut xatolik, Makloren qatori, Teylor qatori.

**Аннотация**

Приближение — одно из важнейших понятий математики. Нахождение значений функций в точке и использование для этого градуированных рядов приносит нам большое удобство.

**Ключевые слова:** ряд ранга, частичная сумма, невязка, абсолютная ошибка, ряд Маклорена, ряд Тейлора.

**Annotation**

Approximation is one of the most important concepts of mathematics. Finding the values of functions at a point and using the graded series for this brings us great convenience.

**Key words:** Rank series, partial sum, residual, absolute error, McLauren series, Taylor series.

$f(x)$ funksiyaning $x = x_0$ qiymatini berilgan aniqlikda hisoblash talab qilingan bo'lsin. Bu funksiya $(-R; R)$ oraliqda darajali qatorga yoyilsin va $x_0 \in (-R; R)$ bo'lsin.

U holda $f(x)$ funksiyaning $x_0$ nuqtadagi aniq qiymati Teylor va Makloren qatorlari bilan taqribiy qiymati esa shu qatorning $n$ −qismiy yig'indisi bilan hisoblanishi mumkin, ya'ni $f(x_0) \approx S_n(x_0)$. Bu tenglikning aniqligi $n$ ning ortishi bilan ortib boradi. Bu tenglikning absolyut xatosi $|R_n(x_0)| = |f(x_0) - S_n(x_0)|$ ga teng bo'ladi.

Agar $f(x_0)$ qiymatni $\varepsilon > 0$ aniqlikda hisoblash talab qilinsa, shunday dastlabki hadlar yig'indisini olish kerak bo'ladiki, bunda $|R_n(x_0)| < \varepsilon$ bo'lishi lozim.

Musbat hadli qatorning qoldig'i $R_n < \int_n^{\infty} f(x)dx$ tengsizlik bilan, ishora almashinuvchi qatorning qoldig'i $|R_n| < |a_{n+1}|$ tengsizlik bilan baholanadi. Bundan tashqari qator qoldig'i $|R_n(x_0)| = \left|\frac{f^{(n+1)}(c)}{(n+1)!}(x_0 - c)^{n+1}\right| < \varepsilon$ tengsizlik bilan ham baholanishi mumkin.

**1-misol.** $e$ sonini $\varepsilon = 0.001$ aniqlikda hisoblang.

$e^x$ funksiyaning quyidagi Makloren qatoriga yoyilmasidan foydalanamiz:

$$e^x = \sum_{n=0}^{\infty} \frac{x^n}{n!} = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \cdots + \frac{x^n}{n!} + \cdots, \quad -\infty < x < +\infty;$$

Bunda $x = 1$ da $e = 1 + 1 + \frac{1}{2!} + \frac{1}{3!} + \cdots + \frac{1}{n!} + \cdots$. Bunda $R_n(1) = \frac{e^c}{(n+1)!}$, $c\epsilon(0;1)$ yoki $e^c < e^1 < 3$ bo‘lishi hisobga olinsa, $R_n(1) = \frac{3}{(n+1)!}$ kelib chiqadi.

$n = 6$ da $R_6(1) = \frac{3}{7!} = 0{,}00069 < 0{,}001$.

Demak,

$$e \approx 1 + 1 + \frac{1}{2!} + \frac{1}{3!} + \frac{1}{4!} + \frac{1}{5!} + \frac{1}{6!} = 2{,}718.$$

**2-misol.** $\cos 18^\circ$ ni 0,0001 aniqlikda hisoblang.

Argumentni radian o‘lchamiga o‘tkazamiz va topilgan sonni quyidagi cosx funksiyaning Makloren qatoriga qo‘yamiz:

$$\cos x = \sum_{n=0}^{\infty} \frac{(-1)^n x^n}{(2n)!} = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} + \ldots + \frac{(-1)^n x^n}{(2n)!} + \ldots, \quad -\infty < x < +\infty$$

Bunda $x = \frac{\pi}{10}$ da

$$\cos 18^\circ = \cos\frac{\pi}{10} = 1 - \frac{1}{2!}\left(\frac{\pi}{10}\right)^2 + \frac{1}{4!}\left(\frac{\pi}{10}\right)^4 + \ldots., \text{bunda } \frac{\pi}{10} = 0{,}31416,$$

$$\left(\frac{\pi}{10}\right)^2 = 0.09870, \qquad \left(\frac{\pi}{10}\right)^4 = 0{,}00974, \quad \left(\frac{\pi}{10}\right)^6 = 0{,}00096$$

Qator ishora almashinuvchi.

Shu sababli

$$a_{n+1} = a_4 = \frac{1}{6!}\left(\frac{\pi}{10}\right)^6 < 0{,}0001 \text{ va } R_n < |a_3|.$$

Demak,

$$\cos 18^\circ \approx 1 - \frac{0{,}09870}{2} + \frac{0{,}00974}{24} \approx 0{,}9511.$$

**3-misol.** ln1,1 ni 0,0001 aniqlikda hisoblang.

$\ln(1 + x)$ funksiyaning quyidagi Makloren qatoriga yoyilmasidan foydalanamiz:

$$\ln(1 + x) = \sum_{n=0}^{\infty} \frac{(-1)^n x^n}{n + 1} = x - \frac{x^2}{2} + \frac{x^3}{3} + \ldots + \frac{(-1)^n x^n}{n + 1} + \ldots, \quad -1 < x < 1$$

Bunda $x = 0{,}1$ da

$$\ln(1{,}1) = \ln(1 + 0{,}1) = 0{,}1 - \frac{0{,}1^2}{2} + \frac{0{,}1^3}{3} = 0{,}1 - 0{,}005 = 0{,}095$$

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