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SECTION: PHYSICS AND MATHEMATICS

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Buxoro davlat universiteti Amaliy matematika va dasturlash texnologiyalari kafedrasi dotsenti,
Rahmonqulova Zarnigor Bahodirovna
Buxoro davlat universiteti Amaliy matematika (sohalar bo'yicha) mutaxassisligi magistri
(Buxoro, O'zbekiston)

FUNKSIYALARNI SONLI INTEGRALLASH

Rezyume. *Maqolada funksiyalarni sonli integrallash masalasi haqida ma'lumot berilgan.*

Kalit so'zlar: *boshlang'ich funksiya, elementar funksiya, integral, aniq integral, aniqmas integral, kvadratur formula.*

Kundalik hayotimizda uchraydigan ko'p muxandislik masalalarini yechishda aniq integrallarni hisoblashga to'g'ri keladi. Faraz qilaylik, $\int_a^b f(x)dx$ hisoblash talab etilsin. Bu yerda f(x) - [a; b] kesmada berilgan uzluksiz funksiya. Bu integralni hisoblashda quyidagi formula (Nyuton–Leybnits formulasi) qo'llaniladi:

$$\int_a^b f(x)dx = F(b) - F(a) \quad (1)$$

bu yerda F(x) – boshlang'ich funksiya. Agar boshlang'ich funksiya F(x) ni elementar funksiyalar orqali ifodalab bo'lmasa yoki integral ostidagi funksiya f(x) jadval ko'rinishida berilsa, u xolda (1) formuladan foydalanish mumkin emas. Bu xolda aniq integralni taqribiy formulalar orqali hisoblashga to'g'ri keladi. Bunday formulalarga kvadratur formulalar deyiladi.

Kvadratur formulalarni keltirib chiqarish uchun aniq integralning geometrik ma'nosini bilish kerak. Agar [a; b] kesmada f(x) ≥ 0 bo'lsa, u xolda $\int_a^b f(x)dx$

ning qiymati son jixatidan y = f(x) funksiyani grafigi hamda x=a, x=b, to'g'ri chiziqlar bilan chegaralangan shakl (figura) ning yuziga teng (1-rasm). Agar [a;b] kesmada f(x)< 0 bo'lsa, integralning qiymati yuqorida keltirilgan shaklning teskari ishora bilan olingan yuziga teng (2-rasm).

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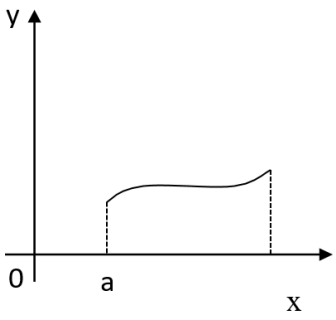
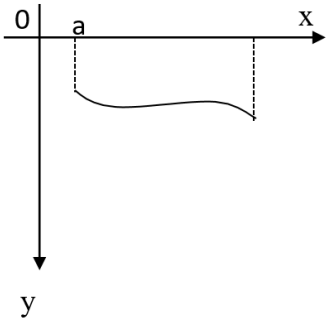


1-rasm



2-rasm

Shunday qilib aniq integralni hisoblash deganda biror shaklning yuzini hisoblash tushuniladi. Endi aniq integralni hisoblash uchun ba'zi taqribiy formulalar bilan tanishib chiqamiz.

Faraz qilaylik, bizdan $\int_a^b f(x)dx$ aniq integralning taqribiy qiymatini topish talab etilsin. $x_0, x_1, x_2, \ldots, x_n$ nuqtalar yordamida [a;b] kesmani p ta teng bo'lakchalarga bo'lamiz. Har bir bo'lakchaning uzunligi $h = \frac{b-a}{n}$. Bo'linish nuqtalari esa:

x_0= a; x_1= a + h; x_2= x + 2h; x_3 = a+3h ... x_{n-1}= a+(n-1)h; x_n = b

Bu nuqtalarni tugun nuqtalar deb ataymiz. f(x) funksiyaning tugun nuqtalaridagi qiymatlari $y_0, y_1, y_2, \ldots y_n$ bo'lsin. Bular y_0 = f(a); y_1 = f(x_1) ... y_n=f(b) larga teng bo'ladi.

Egri chiziqli trapetsiyaning yuzini topish uchun [a,b] kesmani bo'lish natijasida hosil bo'lgan barcha to'rtburchaklarning yuzini hisoblab, ularni jamlash kerak bo'ladi. Albatta bu yuzachalarni hisoblashlarda ma'lum darajada xatoliklarga yo'l qo'yiladi (shtrixlangan yuzachalar). Bularni va aniq integralning geometrik ma'nosini hisobga olsak, quyidagini yozishimiz mumkin bo'ladi:

$$\int_a^b f(x)dx \approx h \cdot y_0 + hy_1 + hy_2 + \cdots + hy_{n-1} = h(y_0 + y_1 + y_2 + \cdots + y_{n-1})$$

$$= h\sum_{k=0}^{n-1} y_k$$

$$\int_a^b f(x)dx \approx h\sum_{k=0}^{n-1} y_k \qquad (2)$$

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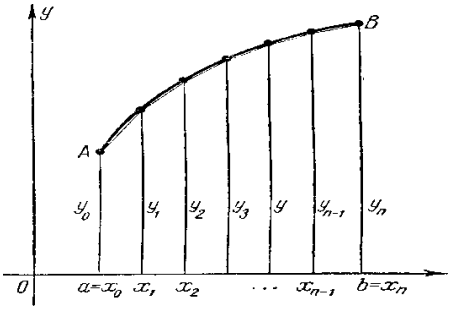

3-rasm

Bu yerda to'g'ri to'rtburchak yuzini hisoblashda uning chap tomon ordinatasi olindi. Agar o'ng tomon ordinatani olsak ham shunday formulaga ega bo'lamiz:

$$\int_a^b f(x)dx \approx h(y_0 + y_1 + y_2 + \cdots + y_{n-1}) = h\sum_{k=0}^{n-1} y_k$$

$$\int_a^b f(x)dx \approx h\sum_{k=0}^{n-1} y_k \quad (3)$$

(2) va (3) lar mos ravishda chap va o'ng formulalar deyiladi. Agar 3- rasmga e'tibor bersak, (2) formula bilan integralning qiymati hisoblanganda integralning taqribiy qiymati aniq qiymatidan ma'lum darajada kamroq chiqadi, (3) yordamida hisoblanganda esa taqribiy qiymat aniq qiymatdan ma'lum darajada kattaroq chiqadi. Ya'ni (2) va (3) formulalar yordamida aniq integralning taqribiy qiymati hisoblanganda bu formulalardan biri integralning aniq qiymatini kami bilan ifodalasa, ikkinchisi esa ko'pi bilan ifodalaydi. 3- rasmdan kurinadiki, (2) va (3) formulalarni qo'llaganda yo'l qo'yiladigan xatolikni kamaytirish uchun bo'linish nuqtalarini iloji boricha ko'proq olish, ya'ni qadam h ni tobora kichraytirish lozim bo'ladi. Albatta, h ni kichraytirish hisoblash jarayonining keskin o'sishiga olib keladi. Bunda amallar soni ko'paygani uchun butun hisoblash jarayoni kompyuterga yuklanadi.

Misol. To`g'ri turtburchaklar formulalari (2) va (3) yordamida $\int_0^1 \frac{0,5dx}{1+2x}$ integralning taqribiy qiymatlari topilsin.

Yechish: Bu erda a=0; b=1; n=10; h=(b- a)/n=0,1.

$$f(x)=\frac{0,5}{1+2x}$$

$$x_0 = a = 0;\ x_1 = a + h = 0,1;\ x_2 = a + 2h = 0,2;\ x_3 = a + 3h = 0,3;$$
$$x_4 = a + 4h = 0,4\ \ldots\ x_9 = a + 9h = 0,9;\ x_{10} = b = 1$$
$$y_0 = f(x) = \frac{0,5}{1+2x} = \frac{0,5}{1+2x} = 0,5;\ y_1 = f(x_1) = \frac{0,5}{1+0,2} = 0,417;$$

$y_2 = f(x_2) = 0,357;\ y_3 = f(x_3) = 0,3125; \ldots\ y_9 = f(x_9) = 0,178;\ y_{10} = f(x_{10}) = 0,166.$ (2) dan $\int_0^1 \frac{0,5dx}{1+2*x} \approx 0,1(0.5 + 0,417 + \cdots + 0,178) = 0,29175$

(3) dan $\int_0^1 \frac{0,5dx}{1+2*x} \approx 0,1(0,417 + 0,357 + \cdots + 0,166) = 0,25835$

Ma'lumki $\int_0^1 \frac{0.5dx}{1+2*x} = \frac{1}{4}ln3, \frac{1}{4}ln3 \approx 0,2746.$

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Bulardan ko'rinadiki, aniq yechim chap va o'ng formulalar orqali topilgan yechimlar orasida yotadi. Topilgan yechimlar $0{,}29175$ va $0{,}25835$ ning o'rta arifmetigini olsak, bu $0{,}2746$ ga teng bo`ladi, bu esa aniq yechim bilan ustma-ust tushadi. Bu xulosalarni nazarga olgan xolda (2) va (3) formulalar hadlarini mos ravishda qo'shib o'rta arifmetigini olsak, quyidagi ifoda hosil bo`ladi:

$$\int_a^b f(x)dx \approx h\left(\frac{1}{2}y_0 + y_1 + y_2 + \cdots + y_{n-1} + \frac{1}{2}y_n\right) = h(\frac{y_0}{2} + \sum_{k=1}^{n-1} y_k + \frac{y_n}{2}) \quad (4)$$

(4) formula *trapetsiyalar formulasi* deb ataladi. Bu formula yordamida topilgan integralning taqribii qiymatining aniqligini oshirish uchun bulinish nuqtalari soni n» ni ikki, uch va h.k. marta oshirish kerak bo'ladi. Albatta bunda ham hisoblash xajmi bir necha marotaba oshadi.

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